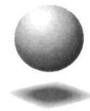
Final RCRA Facility Investigation Report

Modine Manufacturing Facility
Camdenton, Missouri

Prepared by



CH2MHILL

July 2009

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Executive Summary

This RCRA Facility Investigation (RFI) Report summarizes existing data available for the site, summarizes previous remedial activities, assesses the nature and extent of contamination remaining in site soils, reviews fate and transport of the remaining contaminants, and quantifies the potential risk posed by site-related contamination to human health and the environment. This RFI Report is being submitted under the Corrective Action Order on Consent negotiated by Modine and the MDNR in July 1999.

A visual site inspection /preliminary assessment conducted at the Modine facility in 1992 recommended further investigation at a few solid waste management units (SWMUs). None of the SWMUs are currently active. Several investigations were conducted between 1992 and 2007 at the Modine facility to assess the potential for releases from these SWMUs. Based on the results from some of these investigations, remedial activities were conducted to remove contaminated soil during this time period. The data generated from the investigations and remedial activities were evaluated to determine what chemicals remain in site soils that could still pose a potential risk to human health and the environment.

To assess the nature of contamination, soil concentration data representative of current onsite conditions were compared against screening levels based on U.S. Environmental Protection Agency Region 6 Human Health Medium-Specific Screening Levels as part of this RFI. The only chemical identified in excess of the screening levels was trichloroethene (TCE). The evaluation of the TCE data concluded that the extent of TCE contamination has been adequately defined to the concentration previously agreed upon (4 mg/kg) by Modine and the Missouri Department of Natural Resources (MDNR) as a result of previous investigations.

Migration pathways were assessed as part of the RFI, to determine the potential fate and transport of TCE contamination in soil. The leaching to groundwater pathway was evaluated and determined to be incomplete since the TCE remaining in soil at concentrations exceeding the medium specific screening levels is protected from direct exposure to precipitation by a building and the concrete and asphalt surrounding the building.

The risk estimates in the HHRA indicate potential risks within U.S. Environmental Protection Agency's (USEPA's) and MDNR's acceptable cumulative risk levels for future industrial workers and future construction workers from direct contact and for current/future industrial workers from inhalation of indoor air. However, risk estimates exceed MDNR's target risk level for an individual chemical. The vapor intrusion pathway was evaluated using measured indoor air concentrations. When calculating risk estimates, the Cal/EPA toxicity values for TCE were used in accordance with historic agreements with MDNR.

The ecological risk assessment found that although ecological receptors are present nearby, there are no complete pathways to these receptors.

An environmental covenant, which meets the requirements of the Missouri Environmental Covenants Act, RSMo, Section 260.1000 through 260.1039, has been prepared for the Modine Manufacturing Company facility in Camdenton, Missouri. Residential land use is defined as property whose use is unrestricted and that it is either being used for residential use, or is zoned for residential use, or access to the property is not restricted and children under 18 years of age are on the property more than 250 days per year. The environmental covenant provides for activity and use limitations restricting the property to non-residential use, prohibiting drilling or the use of groundwater for domestic purposes, and limitations restricting the disturbance of soil under the existing building. These limitations exclude the use or development of the property or portions of the property for any day care, preschool, playground, athletic field, or residential purposes. These limitations also require the owner or operator to request permission from MDNR at least 60 days before soil disturbance activities beneath the building begin. MDNR may deny the request for soil disturbance or require protective or remedial actions prior to soil disturbance activities based on the findings presented in this report. In addition, the owner or operator of the property is required to allow access to the property for the purpose of environmental groundwater monitoring at existing onsite wells.

Based on results of the RFI, there is no need to move forward with a Corrective Measures Study. The path forward includes MDNR taking the lead to inform the public. Given that no significant concerns are raised by the public that MDNR considers relevant for consideration, the site will be closed with no further action.

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Acronyms and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
AOC	Action Order on Consent
bgs	below ground surface
Cal/EPA	California Environmental Protection Agency
COPC	chemical of potential concern
cVOC	chlorinated volatile organic compound
DCA	dichloroacetic acid
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
cis-1,2-DCE	cis-1,2-dichloroethene
trans-1,2-DCE	trans-1,2-dichloroethene
EI	Environmental Indicator
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ESA	environmental site assessment
FOD	frequency of detection
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HS	Hamilton Sundstrand
IAQ	Indoor Air Quality
IRIS	Integrated Risk Information System
MDNR	Missouri Department of Natural Resources
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
MRBCA	Missouri Risk Based Corrective Action
MSSL	medium specific screening level
NIOSH	National Institute of Occupational Safety and Health
OSHA	U.S. Occupational Safety and Health Administration
PA	preliminary assessment
PCE	tetrachloroethene
PEL	Permissible Exposure Level
ppbv	parts per billion by volume
RAGS	Risk Assessment Guidance for Superfund
RBSV	risk-based screening value
RBTL	risk-based target level
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Level
RfD	reference dose
RFI	RCRA Facility Investigation
RI	remedial investigation

RME	reasonable maximum exposure
SWMU	solid waste management unit
TCA	trichloroacetic acid
TCE	trichloroethene
TLV	Threshold Limit Value
TSD	treatment, storage or disposal
1,1,1-TCA	1,1,1-trichloroethane
1,1,2-TCA	1,1,2-trichloroethane
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound
VSI	visual site inspection

1. Introduction

This RCRA Facility Investigation (RFI) Report summarizes the data available for the site, assesses the nature and extent of contamination remaining in site soils, reviews the fate and transport of the remaining contaminants in the wake of the substantial remedial efforts that have occurred under the Administrative Order and quantifies the potential human health and ecological risk posed by remaining site-related contamination at the Modine Manufacturing Company facility related to past releases from solid waste management units (SWMUs).

This document consists of nine sections:

- Section 1 states the purpose of the RFI report and summarizes the facility location and history, and the regulatory history.
- Section 2 summarizes the site features such as geology, hydrology, hydrogeology, topography, climate and land use.
- Section 3 summarizes the findings from previous investigative work at and around the site and the history of corrective action there.
- Section 4 summarizes the nature and extent of contamination remaining at the Modine facility.
- Section 5 summarizes the potential fate and transport of contamination remaining at the Modine facility.
- Section 6 presents the findings from the human health risk assessment (HHRA) regarding the contamination remaining at the Modine facility.
- Section 7 presents the findings from the ecological risk assessment regarding the contamination remaining at the Modine facility.
- Section 8 presents conclusions and recommendations.
- Section 9 presents references.

1.1 Facility Location

The Modine Manufacturing Company facility is located at 221 (formerly 179) Sunset Drive in Camdenton, Missouri. The legal description for the site is NE ¼, NE ¼, Sec. 26, T. 38 N., R. 17 W., Green Bay Terrace Quadrangle, Camden County, Missouri (Figure 1-1). The facility is bordered on the northwest, north, and east by residences and by a wooded ravine on the south, southwest, and west. The Lake of the Ozarks is 1.25 miles west of the facility.

1.2 Facility History

Dawson Metal Products owned and operated the Modine facility from 1967 to 1972. The company produced air-conditioning coils and feeder parts from aluminum and copper

tubing. Sundstrand Tubular Products purchased the facility in 1972 and continued operating it until 1990. In October 1990, Modine Heat Transfer, Inc., a wholly owned subsidiary of Modine Manufacturing Company, purchased the facility. Modine Heat Transfer merged with Modine Manufacturing Company on April 1, 1997. Modine Manufacturing Company is the current owner/operator of the facility.

The manufacturing building was constructed in 1967. Since that time, the facility has undergone four expansions (1970, 1973, 1979, and 1983). The building also underwent complete interior renovation in 1997. As part of the renovation, all degreasing units were removed and all recessed floor portions brought to grade. The impetus for the renovation was a product line change that required replacement of all equipment in the plant other than the wastewater system (package plant) and the electrical system.

Before 1997, the Modine facility produced aluminum and copper heat transfer units. The manufacturing process required the cutting and mechanical expanding of aluminum and copper to bond the copper tubing with the aluminum fins. A vapor degreasing process was necessary to adequately clean (remove oil and dirt) from the various parts and assembled units prior to further processing. The vapor degreasers at the facility used trichloroethylene (TCE) until Modine purchased the facility in 1990. Modine used 1,1,1-trichloroethane (1,1,1-TCA) in the vapor degreasers from 1990 until 1993. In 1993, 1,1,1-TCA was replaced with methylene chloride, the solvent of choice until 1997 when all degreasers were removed.

Since 1997, the facility has produced radiators (larger heat transfer units) using a different manufacturing process, which requires the bonding of aluminum to aluminum by a brazing process. No chlorinated vapor degreasing is used in the cleaning of the radiators since these units and parts are cleaned using aqueous-based alkali cleaners.

1.3 Regulatory History

A Resource Conservation and Recovery Act (RCRA) Part A Permit application to operate a storage facility was submitted to the U.S. Environmental Protection Agency (USEPA) by Sundstrand Corp. (now Hamilton-Sundstrand) in 1980. Revisions to the Part A were filed in 1983 and 1990. A RCRA Part B Permit application was never filed; therefore, the facility was operated as a treatment, storage, or disposal (TSD) facility under interim status.

Before Modine purchased the site, Sundstrand submitted a Closure Plan in September 1990 to terminate its interim status as a TSD facility and hold generator status only. The Closure Plan addressed three former storage areas, all on the west side of the building. In March 1992, Modine submitted a Revised Closure Plan, which the Missouri Department of Natural Resources (MDNR) approved, with modifications, in November 1992.

Concurrent with the RCRA activities, the Superfund Section of the MDNR Hazardous Waste Program contracted Jacobs Engineering Group through USEPA Region 7 to conduct a visual site inspection (VSI) and preliminary assessment (PA) of the facility in 1992. The VSI/PA identified 35 RCRA regulated SWMUs and four areas of concern. Of those, only six were recommended for further investigation. These consisted of:

- SWMU 1 (Hulett Lagoon)
- SWMU 2 (Mudpits)
- SWMU 4 (Tank and Drum Storage Area 1)

- SWMU 5 (Tank and Drum Storage Area 2)
- SWMU 19 (Monorail Vapor Degreaser and Still M185)
- SWMU 31 (Tank and Drum Storage Area 3) and SWMU 26 (Monorail Vapor Degreaser and Still M567) (collocated)

Several investigations and remedial activities related to the SWMUs were conducted from 1992 through 2007. Section 3 of this report summarizes the results of those investigations.

Modine and the MDNR negotiated a Corrective Action Order on Consent (AOC) in July 1999 to facilitate the investigation and remedial activities related to the onsite SWMUs. The soil investigation and remediation along with the groundwater investigation are being addressed by Modine, under the AOC, and by Hamilton Sundstrand (HS). Current groundwater investigations are being addressed by HS under a letter of agreement with MDNR as part of the Cooperative Program. The Cooperative Program exists under the "Superfund" Section of the MDNR Hazardous Waste Program to allow compliant businesses to make progress at a site without the need of an enforcement action (Consent Decree).

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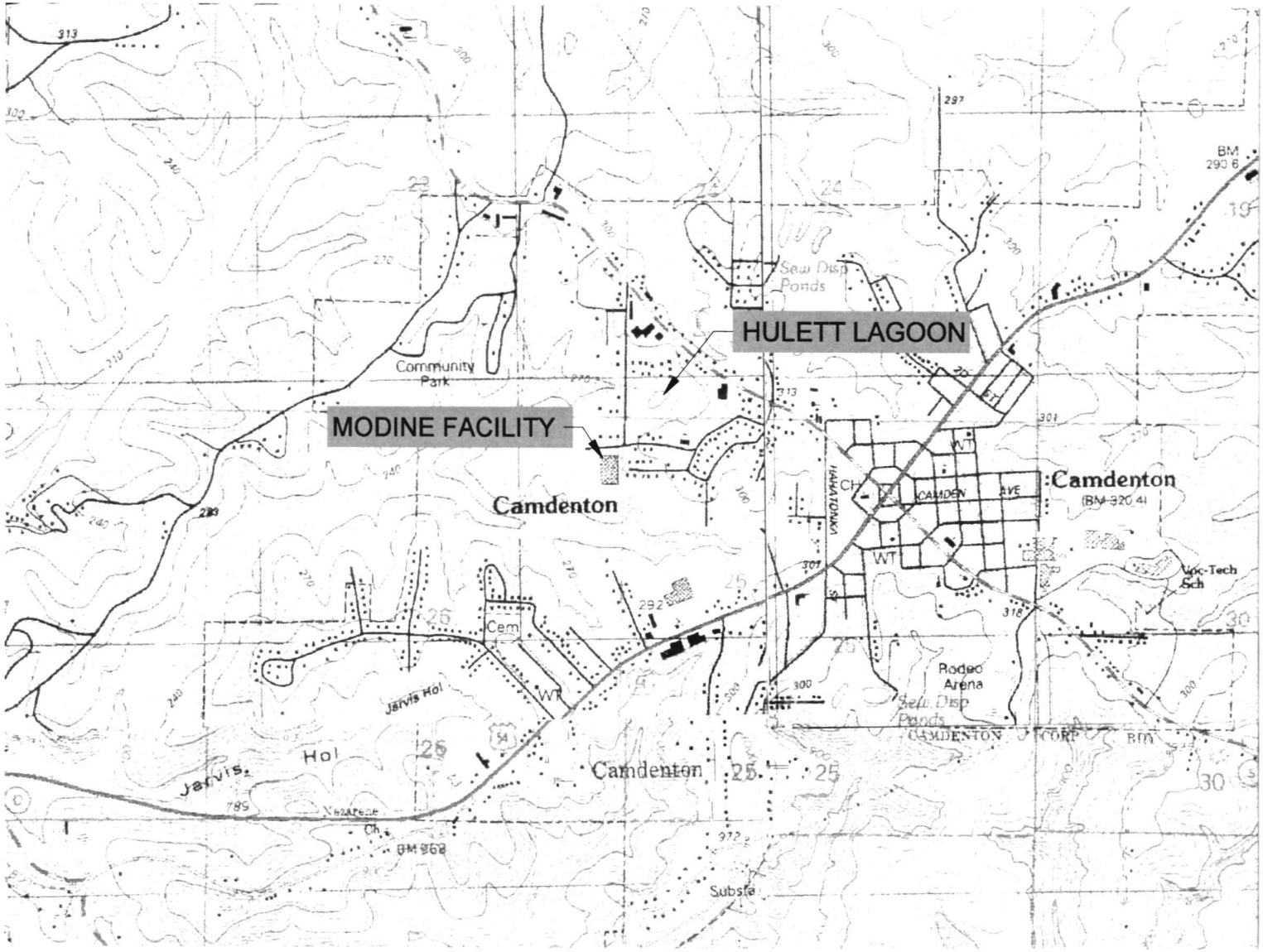

NOT TO SCALE

NOTE:
THE HULETT LAGOON IS APPROXIMATELY 1,000 FEET NORTHEAST OF THE MODINE MANUFACTURING COMPANY FACILITY.

FIGURE 1-1
SITE LOCATION MAP
MODINE MANUFACTURING COMPANY
CAMDENTON, MISSOURI

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2. Site Features

2.1 Geology

The Modine site was leveled for construction of the original building and subsequent additions with 5 to 15 feet of clay fill, gravel and construction debris. The fill is deepest in the southwestern part of the site. The first natural material beneath the fill is the Roubidoux Formation residuum. The upper part of the unit consists of silty, sandy, red clay with chert fragments, the lower portion relatively insoluble relict sandstone, chert beds, and residual clay, resultant from the deep weathering of the Roubidoux Formation. Soil borings and excavations conducted at the site indicate that the predominant soil type is clay and that the thickness of the unconsolidated overburden typically is 5 to 30 feet and as much as 50 feet on the extreme southwestern part of the facility grounds. Exhibits 2-1 through 2-8 present representative borings logs from investigations at the site. The boring logs demonstrate that clays are the predominant soil type beneath the site.

The uppermost bedrock is the Ordovician Age Roubidoux Formation. The Roubidoux Formation consists of dolomite, sandy dolomite and sandstone. Because of extensive weathering and dissolution of the carbonate parts of the Roubidoux Formation, the bedrock surface is uneven and only isolated erosional remnants of the Roubidoux Formation are found to exist beneath the site.

The first competent bedrock unit beneath the site is the Gasconade Dolomite. The Gasconade is a cherty dolomite estimated to be roughly 300 feet thick. The Gunter Sandstone member forms the basal unit of the Gasconade. The Gunter Sandstone member separates the Cambrian and Ordovician age strata. The Gunter is estimated to be 20 feet thick in the area.

The Eminence Dolomite underlies the Gunter Sandstone. It represents the top of the Cambrian Age rock in the area. The Eminence Dolomite consists predominately of medium to massively bedded dolomite and minor chert. It is underlain by the Potosi Dolomite, which is a thickly bedded, medium to finely crystalline dolomite that characteristically contains an abundance of quartz druse. The Derby-Doerun Dolomite underlies the Potosi Dolomite. It consists of thin bedded dolomite that alternates with thin-bedded siltstones and shales. The Derby-Doerun Dolomite is the deepest rock formation logged in nearby wells. Underlying the Derby-Doerun Dolomite are the shaley Davis Formation, the Bonneterre Formation, and the Lamotte Formation. The entire Cambrian section is estimated to be more than 1,150 feet thick.

Modine conducted a field fracture survey in 1996. Bedrock outcrops in the erosional valleys north, south, and west of the Modine facility were inspected, and the strike and dip of the fractures were measured using a Brunton compass. The orientation of 173 fractures was measured from 20 outcrop locations. The primary fracture orientation is nearly vertical and trends N50°E. HS conducted an additional fracture survey as part of the remedial investigation (RI) in 2003, confirmed a predominately N50°E fracture trend with a secondary fracture set orientation of N35°W.

2.2 Hydrology

The principal potable aquifer in the Camdenton area is the Ozark Aquifer. The Ozark Aquifer consists of all bedrock units beneath the site that are located above the Derby-Doerun Dolomite. The total thickness of the aquifer is roughly 950 feet.

The Gunter Sandstone yields an adequate supply of potable quality water for domestic use. Therefore, most private wells in the area are completed within this unit and do not penetrate the underlying Cambrian Formations. The major sources of municipal drinking water in the area, including the City of Camdenton municipal wells, are completed within the Eminence and Potosi dolomites.

2.3 Hydrogeology

Shallow, nonpotable groundwater occurs sporadically during the wetter months within the unconsolidated overburden atop the bedrock surface. Based on results from investigations at and around the site, the first encounter of sustainable groundwater is deep within the underlying bedrock. Two distinct groundwater zones have been identified at the site: a "perched" zone and a "deep" aquifer zone. Groundwater within both zones occurs primarily within secondary porosity features (fractures, bedding plane separations, dissolution cavities). Groundwater flow is affected most by the primary fracture pattern and to a lesser degree by the secondary fracture pattern.

The "deep" aquifer system is separated from the overlying "perched" zone by an argillaceous interval (low permeability layer) that typically ranges in thickness between 30 and 40 feet. Groundwater within the "perched" zone system occurs at elevation between 817 and 828 feet above mean sea level. Saturated thickness of the "perched" zone ranges between 1 foot and 8 feet, and appears to be controlled by the surface configuration of the low permeability zone that forms the base of the "perched" zone. The general flow direction also appears to be influenced by the occurrence, depth, and slope of the low permeability zone. Groundwater within the "deep" aquifer system occurs at 781 to 792 feet above mean sea level, roughly 200 feet below ground. Groundwater flow in the "perched" zone generally is from northeast to southwest across the site. The low permeability zone is breached by erosion in the ravines south and west of the facility. The general groundwater flow direction in the "deep" aquifer is from east to west.

2.4 Topography

The Modine facility is located on an east-to-west trending ridge top in the northwestern portion of the Salem Plateau, which is a subdivision of the Ozark Plateau. The topography of the area and region is undulating and characterized by a nonglaciated terrace with deeply incised ephemeral streams. Elevation at the site is 960 feet above mean sea level; topographic relief is roughly 20 feet across the site. The elevation drops steeply into the ravine immediately south of the facility. The base of the ravine is 195 feet lower than the elevation of the facility.

2.5 Climate

Based upon climate data for Camdenton, provided by the Midwest Regional Climate Center, average temperatures in spring and summer range from the mid-40s (degrees Fahrenheit [°F]) to the high 80s and low 90s. Typically, fall and winter temperatures range from the low 20s to the mid-40s. The Camdenton area typically receives some type of precipitation more than 101 days of the year, with an average annual rainfall of 36.2 inches and an average annual snowfall of 17.0 inches. The prevailing wind direction is from the southwest to the northeast.

2.6 Land Use

The Modine facility is surrounded by wooded land and residences. The site surface is covered with asphalt or gravel (used as a parking area)and a building. The facility has been used for industrial purposes since at least 1967 and will continue to be zoned as industrial land for the foreseeable future.

The Hulett lagoon site is surrounded by undeveloped wooded land and residential and commercial properties. The former lagoon is now a generally flat, open field covered with native vegetation with surface runoff toward the northwest entering intermittent drainages that trend to the west. An apartment complex is located north and upgradient of the former lagoon. The former lagoon is bordered on the west by a wooded area about 500 feet wide and beyond by Dawson Road and residences. Wooded areas border the south and east of the former lagoon area with residences beyond the southern wooded border, and commercial property (along Missouri State Highway 5 and 7) beyond the eastern wooded border.

Exhibit 2-1

1991 SWMU 26 and SWMU 31 Boring Logs

LAW ENVIRONMENTAL
911 WASHINGTON AVENUE
SUITE 160
ST. LOUIS, MISSOURI 63101
(314) 621-9334

TEST BORING RECORD

CLIENT ▶ Modine	LOCATION ▶
BORING NO. ▶ HA-1	Modine Heat Transfer, Inc.
DATE ▶ 10/5/91	Camdenton, MO #53-1543
LOGGED BY ▶ DWW/CHC	DRILLED BY ▶ Law Environmental
DRILLING METHOD ▶ Hand Auger	SAMPLING METHOD ▶ Hand Auger

COMMENTS: Headspace reading measured with an HNU PID using a 10.2 eV lamp.

HOLE DIA. 3.0 In.

TOTAL DEPTH 4.6 Ft.

HEADSPACE READING (ppm)	MOISTURE CONTENT	DENSITY	SAMPLE NO.	DEPTH	SAMPLE RECOVERY (inches)	PENETRATION RESISTANCE	STRATIGRAPHY	REMARKS
				0			4-inch concrete slab.	
6.0	M		1	1			8-inch concrete slab.	
				2			Gravel base.	
25	M		*2	3			Red silty CLAY (CL) with gravel.	
				4			Brown and gray silty CLAY (CL).	
7.0	M		3				Exploration terminated at 4.6 Ft. due to auger refusal.	

Ground water not encountered during exploration.

* Sample submitted for analysis.

LAW ENVIRONMENTAL
911 WASHINGTON AVENUE
SUITE 160
ST. LOUIS, MISSOURI 63101
(314) 621-9334

TEST BORING RECORD

CLIENT ▶ Modine	LOCATION ▶
BORING NO. ▶ HA-2	Modine Heat Transfer, Inc.
DATE ▶ 10/5/91	Camdenton, MO #53-1543
LOGGED BY ▶ CHC/DWW	DRILLED BY ▶ Law Environmental
DRILLING METHOD ▶ Hand Auger	SAMPLING METHOD ▶ Hand Auger

COMMENTS: Headspace reading measured with an HNU PID using a 10.2 eV lamp.

HOLE DIA. 3.0 In.

TOTAL DEPTH 4.3 Ft.

HEADSPACE READING (ppm)	MOISTURE CONTENT	DENSITY	SAMPLE NO.	DEPTH	SAMPLE RECOVERY (inches)	PENETRATION RESISTANCE	STRATIGRAPHY	REMARKS
				0			4-inch concrete slab.	
6.0	M-D		1	1			8-inch concrete slab.	
				2			Red silty CLAY (CL) with gravel.	
5.0	D		2	3			Brown and gray silty CLAY (CL).	
7.0	D		*3	4			Exploration terminated at 4.3 Ft. due to auger refusal.	

Ground water not encountered during exploration.

* Sample submitted for laboratory analysis.

LAW ENVIRONMENTAL
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SUITE 160
ST. LOUIS, MISSOURI 63101
(314) 621-9334

TEST BORING RECORD

CLIENT ▶ Modine	LOCATION ▶
BORING NO. ▶ HA-3	Modine Heat Transfer, Inc.
DATE ▶ 10/5/91	Camdenton, MO #53-1543
LOGGED BY ▶ CHC/DWW	DRILLED BY ▶ Law Environmental
DRILLING METHOD ▶ Hand Auger	SAMPLING METHOD ▶ Hand Auger

COMMENTS: Headspace reading measured with an HNU PID using a 10.2 eV lamp.

HOLE DIA. 3.0 In.

TOTAL DEPTH 3.5 Ft.

HEADSPACE READING (ppm)	MOISTURE CONTENT	DENSITY	SAMPLE NO.	DEPTH	SAMPLE RECOVERY (inches)	PENETRATION RESISTANCE	STRATIGRAPHY	REMARKS
				0			4-inch concrete slab.	
9.0	M-D		*1	1			8-inch concrete slab.	
				2			Red silty CLAY (CL).	
6.0	D		2	3			Brown and gray silty CLAY (CL).	

Exploration terminated at 3.5 Ft. due to auger refusal.

Ground water not encountered during exploration.

* Sample submitted for laboratory analysis.

TEST BORING RECORD

LAW ENVIRONMENTAL
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SUITE 160
ST. LOUIS, MISSOURI 63101
(314) 621-9334

CLIENT ▶ Modine	LOCATION ▶
BORING NO. ▶ HA-4	Modine Heat Transfer, Inc.
DATE ▶ 10/8/91	Camdenton, MO #53-1543
LOGGED BY ▶ D. Wyatt	DRILLED BY ▶ Law Environmental
DRILLING METHOD ▶ Hand Auger	SAMPLING METHOD ▶ Hand Auger

COMMENTS: Headspace reading measured with an HNU PID using a 10.2 eV lamp.

HOLE DIA. 3.0 In.

TOTAL DEPTH .75 Ft.

HEADSPACE READING (ppm)	MOISTURE CONTENT	DENSITY	SAMPLE NO.	DEPTH	SAMPLE RECOVERY (inches)	PENETRATION RESISTANCE	STRATIGRAPHY	REMARKS
2.0	W		*1	0			Concrete slab. Base rock.	

Exploration terminated at .75 Ft. due to auger refusal.

Ground water rose above borehole following completion of boring.

* Sample submitted for laboratory analysis.

TEST BORING RECORD

PAGE 1 of 1

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911 WASHINGTON AVENUE
SUITE 160
ST. LOUIS, MISSOURI 63101
(314) 621-9334

CLIENT ▶ Modine	LOCATION ▶
BORING NO. ▶ HA-5	Modine Heat Transfer, Inc.
DATE ▶ 10/8/91	Camdenton, MO #53-1543
LOGGED BY ▶ D. Wyatt	DRILLED BY ▶ Law Environmental
DRILLING METHOD ▶ Hand Auger	SAMPLING METHOD ▶ Hand Auger

COMMENTS: Headspace reading measured with an HNU PID using a 10.2 eV lamp.

HOLE DIA. 3.0 In.

TOTAL DEPTH 2.8 Ft.

HEADSPACE READING (ppm)	MOISTURE CONTENT	DENSITY	SAMPLE NO.	DEPTH	SAMPLE RECOVERY (inches)	PENETRATION RESISTANCE	STRATIGRAPHY	REMARKS
				0			Concrete slab.	
42	W		*1	1			Red silty CLAY (CL).	
				2				
30	W		2				Exploration terminated at 2.8 Ft. due to auger refusal.	

Ground water rose above borehole following completion of boring.

* Sample submitted for laboratory analysis.

Exhibit 2-2

1991 SWMU 4 and SWMU 5 Boring Logs

LAW ENVIRONMENTAL
911 WASHINGTON AVENUE
SUITE 160
ST. LOUIS, MISSOURI 63101
(314) 621-9334

TEST BORING RECORD

CLIENT ▶ Modine	LOCATION ▶ Modine Heat Transfer, Inc.
BORING NO. ▶ B-1	Camdenton, MO #53-1543
DATE ▶ 10/8/91	DRILLED BY ▶ Layne Western
LOGGED BY ▶ D. Wyatt	SAMPLING METHOD ▶ Cont. Sampler
DRILLING METHOD ▶ HSA	

COMMENTS: Headspace reading measured with an HNU PID using a 10.2 eV lamp.

HOLE DIA. 6.0 In.

TOTAL DEPTH 6.5 Ft.

HEADSPACE READING (ppm)	MOISTURE CONTENT	DENSITY	SAMPLE NO.	DEPTH	SAMPLE RECOVERY (inches)	PENETRATION RESISTANCE	STRATIGRAPHY	REMARKS
				0			Gravel.	
				1				
				2			Red silty CLAY (CL), some gravel.	
8.2	P-M		*1	3	24			
				4			Gray silty CLAY (CL).	
6.8	P-M		2	5	30		Red silty CLAY (CL) and gravel.	
				6			Fragmented chert particles.	

Exploration terminated at 6.5 Ft. due to auger refusal.

Ground water not encountered during exploration.

* Sample submitted for laboratory analysis.

LAW ENVIRONMENTAL
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SUITE 160
ST. LOUIS, MISSOURI 63101
(314) 621-9334

TEST BORING RECORD

CLIENT ▶ Modine	LOCATION ▶
BORING NO. ▶ B-2	Modine Heat Transfer, Inc.
DATE ▶ 10/8/91	Camdenton, MO #63-1543
LOGGED BY ▶ D. Wyatt	DRILLED BY ▶ Layne Western
DRILLING METHOD ▶ HSA	SAMPLING METHOD ▶ Cont. Sampler

COMMENTS: Headspace reading measured with an HNU PID using a 10.2 eV lamp.

HOLE DIA. 6.8 In.

TOTAL DEPTH 8.5 Ft.

HEADSPACE READING (ppm)	MOISTURE CONTENT	DENSITY	SAMPLE NO.	DEPTH	SAMPLE RECOVERY (inches)	PENETRATION RESISTANCE	STRATIGRAPHY	REMARKS
				0			Gravel.	
				1				
				2			Gray silty CLAY (CL) with organics.	
8.2	P		*1	3	28			
				4				
7.4	P		2	5	13		Brown and gray silty CLAY (CL) with gravel.	
				6				
				7				
				8			Fragmented chert particles.	

Exploration terminated at 8.5 due to auger refusal.

Ground water not encountered during exploration.

* Sample submitted for laboratory analysis.

Exhibit 2-3

1993 SWMU 4 and SWMU 5 Boring Logs

PROJECT NAME AND SITE LOCATION
MODINE - CAMDENTON, MISSOURI

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
53-3634	CME	7/7/93	1 of 1	B-6

SAMPLE NO.	BLOWS/FOOT	RECOVERY INTRVL	TYPE	H20 CONTENT (%)	OVA/HNU READINGS (MDU)	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	WELL
									SURFACE	
S1				M	400				Dense grade aggregate (FILL).	
S2				M	1000				Gray-green, silty CLAY (CL).	
S3				M	500	CL		5	Brown, stiff CLAY (CL).	
S4				M	30					
S5				M	30				Red, stiff CLAY (CL).	
								10	Boring terminated at 10.0 Ft.	

Comments:
- Headspace Reading OVA Model 108.
- CME 6" HSA
- Sample S2 selected for laboratory analyses.

TEST BORING RECORD

LAW ENVIRONMENTAL

PROFESSIONAL ENGINEERING AND EARTH-SCIENCE CONSULTING FIRM

PROJECT NAME AND SITE LOCATION				
MODINE - CAMDENTON, MISSOURI				
PROJECT NO. 53-3634	RIG TYPE CME	DATE 7/7/93	SHEET 1 of 1	BORING NO. B-7

SAMPLE NO.	BLOWS/FOOT	RECOVERY INTRVL	TYPE	H20 CONTENT (%)	OVA/HNU READINGS (MDU)	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	WELL
									SURFACE	
									Asphalt and dense grade aggregate (FILL).	
S1				M	200				Brownish-red, stiff CLAY (CL), little coarse gravel.	
S2				--	--				No recovery.	
S3				M	40	CL		5		
S4				M	25					
S5				M	10				Red, stiff CLAY (CL).	
								10	Boring terminated at 10.0 Ft.	

Comments:
- Headspace Reading OVA Model 108.
- CME 6" HSA
- Sample S1 selected for laboratory analyses.

TEST BORING RECORD

LAW ENVIRONMENTAL

PROFESSIONAL ENGINEERING AND EARTH-SCIENCE CONSULTING FIRM

PROJECT NAME AND SITE LOCATION
MODINE - CAMDENTON, MISSOURI

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
53-3634	CME	7/7/93	1 of 1	B-8

SAMPLE NO.	BLOWS/FOOT	RECOVERY INTRVL	TYPE	H20 CONTENT (%)	OVA/HNU READINGS (MDU)	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	WELL
									SURFACE	
S1				--	--				Asphalt and dense grade aggregate (FILL). No recovery.	
S2				M	300				Brown, silty CLAY (CL), little coarse gravel.	
S3				M	60	CL		5		
S4				M	40				Brownish-red, silty CLAY (CL).	
S5				M	40				Red, stiff CLAY (CL), with sand.	
								10	Boring terminated at 10.0 Ft.	

Comments:
- Headspace Reading OVA Model 108.
- CME 6" HSA
- Sample S2 selected for laboratory analyses.

TEST BORING RECORD

LAW ENVIRONMENTAL

PROFESSIONAL ENGINEERING AND EARTH-SCIENCE CONSULTING FIRM

PROJECT NAME AND SITE LOCATION				
MODINE - CAMDENTON, MISSOURI				
PROJECT NO. 53-3634	RIG TYPE CME	DATE 7/7/93	SHEET 1 of 1	BORING NO. B-10

SAMPLE NO.	BLOWS/FOOT	RECOVERY INTRVL	TYPE	H20 CONTENT (%)	OVA/HNU READINGS (MDU)	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	WELL
									SURFACE	
									Dense grade aggregate (FILL).	
S1				P	70					
S2				M	100				Gray CLAY (CL), little fine sand.	
S3				M	50	CL		5	Gray-brown, sandy CLAY (CL).	
S4				M	30				Brownish-red, stiff CLAY (CL).	
S5				M	20				Red, stiff CLAY (CL).	
								10		
									Boring terminated at 10.0 Ft.	

Comments:
- Headspace Reading OVA Model 108.
- CME 6" HSA
- Sample S2 selected for laboratory analyses.

TEST BORING RECORD

LAW ENVIRONMENTAL

PROFESSIONAL ENGINEERING AND EARTH-SCIENCE CONSULTING FIRM

PROJECT NAME AND SITE LOCATION
MODINE - CAMDENTON, MISSOURI

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
53-3634	CME 75	7/7/93	1 of 1	B-11

SAMPLE NO.	BLOWS/FOOT	RECOVERY INTRVL	TYPE	H20 CONTENT (%)	OVA/HNU READINGS (MDU)	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	WELL
									SURFACE	
S1				P	15				Dense grade aggregate (FILL).	
S2				--	--				Brown, silty CLAY (CL).	
S3				M	10	CL		5		
S4				--	--				Brown to red, silty CLAY (CL).	
S5				M	10				Red, silty CLAY (CL).	
								10	Boring terminated at 10.0 Ft.	

Comments:
- Headspace Reading OVA Model 108.
- CME 6" HSA
- Sample S1 selected for laboratory analyses.

TEST BORING RECORD

LAW ENVIRONMENTAL

PROFESSIONAL ENGINEERING AND EARTH-SCIENCE CONSULTING FIRM

Exhibit 2-4

1997 SWMU 26 and SWMU 31 Boring Logs

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-21-97
Surface Conditions: Concrete

PROBE ID P-1

Monitoring Well Data	
Pipe: NA	Elevation:
Screen: NA	Datum:
Slot: NA	Ground Surface:
Sand: NA	Measuring Pt:
	Top of Casing:

Sample Type
CT - Cuttings; SS - Split Spoon; WA - Wash Sample; CC - Continuous Core; RX - Rock Core; ST - Shelby Tube

DESCRIPTION	USCS	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0 - 1' Concrete and Gravel Fill Material		0					
CLAY, reddish brown, with cherty gravel, soft.	CL	1	0.0		N	1-3	CC
		2					
CLAY, reddish brown, with cherty gravel, moist, stiff.		3	1.3		N	3-7	CC
		4					
		5					
		6					
CLAY, reddish brown, with grey stringers, cherty gravel, slight solvent odor.		7	11.5		N	7-8	CC
		8	8.2	Bentonite	Y	8-12	CC
CLAY, reddish brown, with grey stringers, abundant cherty gravel from 10-12', solvent odor (strong at 12'), dry, stiff.		9					
		10					
		11					
CLAY, reddish brown, with black and grey stringers, cherty gravel dry, stiff.		12	15.7		N	12-16	CC
		13					
		14					
		15					
SILTY CLAY, reddish brown, with black and grey stringers, cherty gravel, dry, stiff.		16	28.4		Y	16-17	CC
		17					
Geoprobe Refusal at 17.0'.		18					
		19					
		20					
		21					
		22					
		23					
		24					
		25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-21-97
Surface Conditions: Concrete

PROBE ID P-2

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation:
Datum:
Ground Surface:
Measuring Pt:
Top of Casing:

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-10" Concrete			0					
CLAY, reddish brown, with cherty gravel, moist.	CL		1	0.0	Bentonite	Y	0-4	CC
			2					
			3					
CLAY, light grey to brown, with cherty gravel, dry, crumbly.			4	0.7		Y	4-6	CC
			5					
Geoprobe Refusal at 6.0'.			6					
			7					
			8					
			9					
			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-21-97
Surface Conditions: Concrete

PROBE ID P-3

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation:
Datum:
Ground Surface:
Measuring Pt:
Top of Casing:

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-10" Concrete			0					
SILTY CLAY, brown, with cherty gravel grading to reddish brown clay, with black and grey stringers and cherty gravel.	CL		1 2 3	0.2	Bentonite	Y	0-4	CC
SILT, brown, with trace clay and cherty gravel, dry, crumbly.	ML		4 5	1.2		Y	4-5.5	CC
Geoprobe Refusal at 5.5'.			6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily ntain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation Dames & Moore personnel before use by others.

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-21-97
Surface Conditions: Concrete

PROBE ID P-4

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation:
Datum:
Ground Surface:
Measuring Pt:
Top of Casing:

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-10" Concrete		0					
SILT, grey grading to brown, with cherty gravel and trace clay, dry, crumbly, soft.	ML	1	3.5	Bentonite	Y	0-4	CC
		2					
		3					
CLAY, grey grading to reddish brown silt, with cherty gravel, dry.	CL	4	3.2		Y	4-6	CC
	ML	5					
Geoprobe Refusal at 6.0'.		6					
		7					
		8					
		9					
		10					
		11					
		12					
		13					
		14					
		15					
		16					
		17					
		18					
		19					
		20					
		21					
		22					
		23					
		24					
		25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-22-97
Surface Conditions: Concrete

PROBE ID P-5

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation:
Datum:
Ground Surface:
Measuring Pt:
Top of Casing:

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-2" Concrete 2-4" Gravel Fill Material		0					
SILT, brown, with trace clay and gravel, dry.	ML	1	0.0	Bentonite	Y	0-4	CC
		2					
		3					
		4	0.0		Y	4-7.5	CC
		5					
CLAY, reddish brown, with cherty gravel, slight solvent odor, dry, stiff.	CL	6					
		7					
Geoprobe Refusal at 7.5'.		8					
		9					
		10					
		11					
		12					
		13					
		14					
		15					
		16					
		17					
		18					
		19					
		20					
		21					
		22					
		23					
		24					
		25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton. Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-22-97
Surface Conditions: Concrete

PROBE ID P-6

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation:
Datum:
Ground Surface:
Measuring Pt:
Top of Casing:

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-5" Concrete SILTY CLAY, reddish brown grading to brown, with cherty gravel, dry.	CL		0 1 2 3	0.0	Bentonite	Y	5"-3.5'	CC
Geoprobe Refusal at 3.5'.			4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-22-97
Surface Conditions: Concrete

PROBE ID P-7

Monitoring Well Data	
Pipe: NA	Elevation:
Screen: NA	Datum:
Slot: NA	Ground Surface:
Sand: NA	Measuring Pt:
	Top of Casing:

Sample Type
CT - Cuttings; SS - Split Spoon; WA - Wash Sample; CC - Continuous Core; RX - Rock Core; ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-6" Concrete			0					
CLAY, reddish brown, with cherty gravel grading to grey, oily and greasy, with cherty gravel, strong petroleum odor, dry, soft.	CL		1	4.1	Bentonite	Y	6"-4.5'	CC
			2					
			3					
SILT, brown, with abundant gravel.	ML		4	7.4		Y	4-5.5'	CC
			5					
Geoprobe Refusal at 5.5'.			6					
			7					
			8					
			9					
			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-22-97
Surface Conditions: Concrete

PROBE ID P-9

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation:
Datum:
Ground Surface:
Measuring Pt:
Top of Casing:

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-4" Concrete			0					
CLAY, reddish brown, with cherty gravel grading to brown silty clay, moist, soft.	CL		1	0.0	Bentonite	Y	0-4	CC
			2					
			3					
SILTY CLAY, brown, soft, moist grading to wet at 6.0'.			4	5.5		Y	4-7	CC
			5					
			6					
Geoprobe Refusal at 7.0'.			7					
			8					
			9					
			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer
Project Number: 27397-005-045
Project: Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Roberts Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: 4-22-97
Surface Conditions: Concrete

PROBE ID P-10

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation:
Datum:
Ground Surface:
Measuring Pt:
Top of Casing:

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-7" Concrete			0					
CLAY, gray grading to reddish brown, with cherty gravel, dry, soft grading to stiff.	CL		1	2.8		N	0-4	CC
			2					
			3					
SILTY CLAY, reddish brown, with cherty gravel, dry, stiff.			4	20.3	Bentonite	Y	4-8	CC
			5					
			6					
			7					
Same as above.			8	2.1		Y	8-11'	CC
			9					
			10					
Geoprobe Refusal at 11.0'.			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Exhibit 2-5

1997 SWMU 2 Boring Logs

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Concrete

PROBE ID P-1

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation
Datum: NA
Ground Surface: NA
Measuring Pt: NA
Top of Casing: NA

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-4 CLAY, yellowish red, with cherty gravel, soft, moist.	CL		0	6.9	BENTONITE GRANULAR	N	0-4	CC
			1					
			2					
			3					
4-8 CLAY, yellowish red, with cherty gravel, wet at 6', grading to grey CLAY, stiff, with black stringers and cherty gravel grading to dark reddish brown CLAY with cherty gravel at the base.			4	16.6		N	4-8	CC
			5					
			6					
			7					
8-10 CLAY, dark reddish brown, with cherty gravel, hard.			8	22.0		Y	8-10	CC
			9					
End of probe at 10.0'.			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Grass

PROBE ID P-2

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation
Datum: NA
Ground Surface: N
Measuring Pt: NA
Top of Casing: NA

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-4 CLAY, yellowish brown, with cherty gravel, soft.	CL		0	11.7	BENTONITE GRANULAR	Y	0-4	CC
			1					
			2					
			3					
4-8 CLAY, yellowish brown grading to dark reddish brown, with abundant cherty gravel, moist.			4	4.5		N	4-8	CC
			5					
			6					
			7					
8-10 Same as above with an abundant amount of chert.			8	7.5		N	8-10	CC
			9					
End of probe at 10.0'.			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Soil

PROBE ID P-3

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation
Datum: NA
Ground Surface: NA
Measuring Pt: NA
Top of Casing: NA

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-4 CLAY, yellowish brown, with organic material (wood), soft, moist.	CL		0	16.6	BENTONITE GRANULAR	N	0-4	CC
			1					
			2					
			3					
4-7 CLAY, yellowish brown, with cherty gravel, dry.			4	20.2		Y	4-7	CC
cherty gravel, moist.			5					
			6					
			7					
End of probe at 7.0' due to refusal.			8					
			9					
			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Soil

PROBE ID P-4

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation
Datum: NA
Ground Surface: NA
Measuring Pt: NA
Top of Casing: NA

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-4 SILTY CLAY, yellowish brown, with cherty gravel, soft, moist.	CL		0	1.5	BENTONITE GRANULAR	N	0-4	CC
			1					
			2					
			3					
4-8 CLAY, reddish brown, with trace gravel and black stringers, hard, moist, with slight solvent odor.			4	45.0		N	4-8	CC
			5					
			6					
			7					
8-10 Same as above.			8	59.5		Y	8-10	
			9					
End of probe at 10.0'.			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Grass

PROBE ID P-5

Monitoring Well Data	Elevation
Pipe: NA	Datum: NA
Screen: NA	Ground Surface: NA
Slot: NA	Measuring Pt: NA
Sand: NA	Top of Casing: NA

Sample Type
CT - Cuttings; SS - Split Spoon; WA - Wash Sample; CC - Continuous Core; RX - Rock Core; ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample: Lab	Sample: Interval	Sample: Type
0-4 SILTY CLAY, yellowish brown, with gravel, dry.	CL		0	0.3	BENTONITE	N	0-4	CC
			1					
			2					
			3					
End of probe at 4.0' due to refusal.			4					
			5					
			6					
			7					
			8					
			9					
			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Soil

PROBE ID P-6

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation
Datum: NA
Ground Surface: NA
Measuring Pt: NA
Top of Casing: NA

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-4 SILTY CLAY, yellowish brown, with trace gravel and grey stringers, soft, moist.	CL		0	3.3	BENTONITE GRANULAR	N	0-4	CC
			1					
			2					
			3					
4-8 CLAY, reddish brown, with cherty gravel, very hard, slight solvent odor.			4	6.3		Y	4-8	CC
			5					
			6					
			7					
8-9 No recovery			8					
End of probe at 9.0' due to refusal.			9					
			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Gravel

PROBE ID P-7B

Monitoring Well Data	Elevation
Pipe: NA	Datum: NA
Screen: NA	Ground Surface: NA
Slot: NA	Measuring Pt: NA
Sand: NA	Top of Casing: NA

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-4 SILTY CLAY, yellowish brown, with trace gravel, slight solvent odor, dry approximately 3" grey silt layer at 3.0'.	CL		0 1 2 3	3.3	BENTONITE	Y	0-4	CC
End of probe at 4.0' due to refusal.			4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Gravel

PROBE ID P-8

Monitoring Well Data	Elevation
Pipe: NA	Datum: NA
Screen: NA	Ground Surface:
Slot: NA	Measuring Pt: NA
Sand: NA	Top of Casing: NA

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample: Lab	Sample: Interval	Sample: Type
0-4 CLAY, grey, with trace gravel, soft.	CL		0 1 2 3	8.1	BENTONITE	Y	0-4	CC
End of probe at 4.0' due to refusal.			4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Client: Modine Heat Transfer, Inc.
Project Number: 27397-030-045
Project: Mud Pit Geoprobe Investigation
Location: Camdenton, Missouri
Driller: Robert's Environmental Drilling, Inc.
Borehole Logged By: Miesche Francis
Drilling Method: Geoprobe
Date Installed: September 3, 1997
Surface Conditions: Concrete

PROBE ID P-9

Monitoring Well Data
Pipe: NA
Screen: NA
Slot: NA
Sand: NA

Elevation
Datum: NA
Ground Surface: NA
Measuring Pt: NA
Top of Casing: NA

Sample Type
CT - Cuttings
SS - Split Spoon
WA - Wash Sample
CC - Continuous Core
RX - Rock Core
ST - Shelby Tube

DESCRIPTION	USCS	Stratigraphy	Depth (ft.)	OVM (ppm)	Completion	Sample Lab	Sample Interval	Sample Type
0-4 CLAY, reddish brown, with trace gravel, soft, moist.	CL		0	0.3	BENTONITE	N	0-4	CC
			1					
			2					
			3					
4-6 SILTY CLAY, reddish brown, with trace gravel, soft, moist.			4	3.9		Y	4-6	CC
			5					
			6					
End of probe at 6.0' due to refusal.			7					
			8					
			9					
			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
			20					
			21					
			22					
			23					
			24					
			25					

Note: This borehole was prepared for hydrogeological and/or environmental assessment purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by Dames & Moore personnel before use by others.

Exhibit 2-6

2001 SWMU 4 and SWMU 5 Boring Logs

SOIL BORING LOG

BORING NUMBER: SB-29

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545.SC.IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1300 11/12/01 **FINISH:** 1325 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: PID HEADSPACE (PPM)	SOIL DESCRIPTION	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1	0' - 4.0'	DP1	2.0	15.6	0.0'-0.5': ROADBASE (GRAVEL). 0.5' - 4.0': CLAY (CL), WITH SILT, FILL MATERIAL, ORANGE WITH BLACK AND GRAY, DRY, LOOSE.	
2						
3				15.9		
4					4.0' - 8.0': SAME AS 0.5'-2.0'	
5						
6	4.0' - 8.0'	DP2	2.0	25.0		
7						
8					8.0' - 10.0': SAME AS 0.5'-2.0' WITH DARKER GRAY MATERIAL MIXED.	COLLECT SAMPLE MO-SB29-8.0/10.0 AT 1320
9	8.0' - 10.0'	DP3	2.0	70.2		
10					END OF BORING @ 10.0' BGS (BEDROCK).	
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
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28						
29						
30						
31						
32						
33						
34						
35						

SOIL BORING LOG

BORING NUMBER: SB-30

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545.SC.IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1335 11/12/01 **FINISH:** 1400 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: PID HEADSPACE (PPM)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1	0' - 4.0'	DP1	4.0	3.9	0.0'-0.5': ROADBASE (GRAVEL) 0.5' - 4.0': CLAY (CL), WITH SILT, FILL MATERIAL, ORANGE WITH BLACK AND GRAY, DRY, LOOSE-MEDIUM.	
2						
3				4.2		
4						
5	4.0' - 8.0'	DP2	3.5	12.5	4.0' - 8.0': SAME AS 0.5'-4.0'.	
6						
7						
8						
9	8.0' - 10.0'	DP3	2.0	18.9	8.0' - 10.0': SAME AS 0.5'-4.0' WITH GRAY (MORE) MIXED IN.	COLLECT SAMPLE MO-SB30-8.0/10.0 AT 1352
10					END OF BORING @ 10.0' BGS (BEDROCK).	
11						
12						
13						
14						
15						
16						
17						
18						
19						
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21						
22						
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26						
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32						
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34						
35						

SOIL BORING LOG

BORING NUMBER: SB-32

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545.SC.IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1415 11/12/01 **FINISH:** 1430 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: PID HEADSPACE (PPM)		SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1	0' - 4.0'	DP1	4.0	25.2		0.0'-0.5': ROADBASE (GRAVEL). 0.5' - 4.0': CLAY (CL), WITH SILT, FILL MATERIAL, ORANGE WITH BLACK AND GRAY, DRY, LOOSE-MEDIUM.	
2							
3							
4							
5	4.0' - 7.0'	DP2	3.0	25.7		4.0' - 7.0': SAME AS ABOVE (0.5'-4.0').	COLLECT SAMPLE MO-SB32-5.0/7.0 AT 1430
6							
7						END OF BORING @ 7.0' BGS (BEDROCK).	
8							
9							
10							
11							
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34							
35							

SOIL BORING LOG

BORING NUMBER: SB-34

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545.SC.IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1440 11/12/01 **FINISH:** 1500 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS / PID HEADSPACE (PPM)	SOIL DESCRIPTION	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1	0' - 4.0'	DP1	4.0	0.0	0.0'-0.5': ROADBASE (GRAVEL). 0.5' - 4.0': CLAY (CL), ORANGE, DRY, MEDIUM, POSSIBLE NATIVE MATERIAL.	
2						
3				50.0		
4						
5	4.0' - 5.5'	DP2	1.5	51.3	4.0' - 5.5': SAME AS ABOVE (0.5'-4.0').	COLLECT SAMPLE MO-SB34-3.5/5.5 AT 1500
6					END OF BORING @ 5.5' BGS (BEDROCK).	
7						
8						
9						
10						
11						
12						
13						
14						
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16						
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35						

SOIL BORING LOG

BORING NUMBER: SB-36

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545 SC IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1520 11/12/01 **FINISH:** 1540 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS / PID HEADSPACE (PPM)		SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1	0' - 4.5'	DP1	4.5	0.0		0.0'-0.5': ROADBASE (GRAVEL).	
2				3.0		0.5' - 4.5': SILTY CLAY (CL/ML), ORANGE, SOME GRAY MIXED IN, DRY, LOOSE, POSSIBLE NATIVE MATERIAL.	COLLECT SAMPLE MO-SB36-2.5/4.5 AT 1540
3							
4				8.0			
5						END OF BORING @ 4.5' BGS (BEDROCK).	
6							
7							
8							
9							
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35							

SOIL BORING LOG

BORING NUMBER: SB-37

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545.SC.IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1540 11/12/01 **FINISH:** 1558 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS / PID HEADSPACE (PPM)		SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	0' - 1.5'	DP1	1.5	0.0		0.0'-0.5': ROADBASE (GRAVEL).	
1				5.8		0.5' - 1.5': SILTY CLAY (CL/ML), ORANGE, SOME GRAY MIXED IN, DRY, LOOSE, POSSIBLE NATIVE MATERIAL.	COLLECT SAMPLE MO-SB37-0.0/1.5 AT 1555
2						END OF BORING @ 1.5' BGS (BEDROCK).	
3							
4							
5							
6							
7							
8							
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SOIL BORING LOG

BORING NUMBER: SB-40

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545.SC.IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1630 11/12/01 **FINISH:** 1640 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: PID HEADSPACE (PPM)		SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1	0' - 4.0'	DP1	4.0	0.0		0.0'-0.5': ROADBASE (GRAVEL). 0.5' - 4.0': CLAY WITH SILT (CL/ML), ORANGE WITH GRAY, BLACK, DRY, MEDIUM	
2				10.0			COLLECT SAMPLE MO-SB40-2.0/4.0 AT 1640
3				40.0			
4						END OF BORING @ 4.0' BGS (BEDROCK).	
5							
6							
7							
8							
9							
10							
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SOIL BORING LOG

BORING NUMBER: SB-49

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545.SC.IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1120 11/13/01 **FINISH:** 1140 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: PID HEADSPACE (PPM)		SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1	0' - 4.0'	DP1	4.0	0.0		0.0'-0.5': ROADBASE (GRAVEL).	
2						0.5' - 4.0': CLAY WITH SOME SILT (CL/ML), DARK GRAY, DRY, STIFF.	
3				4.3			
4						4.0' - 6.0': SAME AS ABOVE (0.5'-4.0').	
5							
6	4.0' - 8.0'	DP2	4.0	5.8		6.0' - 8.0': CLAY WITH GRAVEL (CL/GP), ORANGE, LOOSE, DRY.	
7							
8						8.0' - 12.5': SAME AS 6.0'-8.0'.	
9							
10	8.0' - 12.5'	DP3	4.5	7.8			
11							COLLECT SAMPLE MO-SB49-10.5/12.5 AT 1140
12							
13						END OF BORING @ 12.5' BGS (BEDROCK).	
14							
15							
16							
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33							
34							
35							

SOIL BORING LOG

BORING NUMBER: SB-51A

PROJECT: MODINE MANUFACTURING COMPANY
PROJECT NUMBER 168545.SC.IN
ELEVATION: NOT SURVEYED
LOCATION: CAMDENTON, MO
DRILLING METHOD: GEOPROBE (VAN MOUNTED)
DRILLING CONTRACTOR: INNOVATIVE PROBING SOLUTIONS
WATER LEVELS: NO WATER
START: 1100 11/13/01 **FINISH:** 1115 **LOGGER:** J KENNEDY

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL (FT)	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS / PID HEADSPACE (PPM)		SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1	0' - 2.5'	DP1	2.5	0.0		0.0'-0.5': ROADBASE (GRAVEL).	
2				13.0		0.5' - 2.5': CLAY WITH SILT (CL/MH), DARK GRAY, DRY, LOOSE.	
3						END OF BORING @ 2.5' BGS (BEDROCK).	
4				PID			COLLECT SAMPLE MO-SB51A-0.5/2.5 AT 1115
5				3.2 PPM			
6				OVER			
7				HOLE			
8							
9							
10							
11							
12							
13							
14							
15							
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35							

Exhibit 2-7

2006 SWMU 26 and SWMU 31 Boring Logs

CH2MHILL

PROJECT NUMBER	BORING NUMBER	SHEET 1 OF 1
	MO-MP-01	

SOIL BORING LOG

PROJECT : Modine — LOCATION : Camdenton MO
ELEVATION : — — DRILLING CONTRACTOR : PSA
DRILLING METHOD AND EQUIPMENT USE : Geoprobe/DPT
WATER LEVELS Not Encountered — START : 10/26/2006 — END : 10/26/2006 — LOGGER : G. Roberts

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	TEST AND INSTRUMENTATION PID/PPM	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	REMARKS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
0				0.0 ppm	0.0 - Concrete	
				0.0 ppm	0.3 - Lean CLAY with GRAVEL (CL), reddish brown, moist, stiff	
1						
	0-3.0	3/3	DP-1			
2						
3						
				0.0 ppm	3.0 - Lean CLAY with cherty GRAVEL (CL), brown, moist, stiff	
4						
				0.0 ppm	4.0 - CLAY (CH), reddish brown, moist, stiff	
	3-6.0	3/3	DP-2			
5						
6						
7						
				0.0 ppm		
	6-9.0	3/3	DP-3			
8						
9						
10						
	9-11.0	2/2	DP-4	0.0 ppm		
11					Refusal @ 11' bgs	

CH2MHILL

PROJECT NUMBER	BORING NUMBER	SHEET 1 OF 1
	MO-MP-03	

SOIL BORING LOG

PROJECT : Modine — LOCATION : Camdenton MO

ELEVATION : — — DRILLING CONTRACTOR : PSA

DRILLING METHOD AND EQUIPMENT USE : Geoprobe/DPT

WATER LEVELS : Not Encountered — START : 10/26/2006 — END : 10/26/2006 — LOGGER : G. Roberts

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	TEST AND INSTRU-MENTATION PID/PPM	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	REMARKS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
0				0.0 ppm	0.0 - Gravel	
				0.0 ppm	0.2 - Fat CLAY with GRAVEL (CH), reddish brown, moist, stiff	
1						
	0-3.0	3/3	DP-1			
2						
3						
4						
				0.0 ppm	4.0 - CLAY (CH), reddish brown, moist, stiff	
	3-6.0	3/3	DP-2			
5						
6						
				0.0 ppm	6.0 - CLAY with chert GRAVEL (CH), reddish brown, moist, stiff	
7						
				0.0 ppm		
	6-9.0	3/3	DP-3			
8						
9						
10				0.0 ppm		
	9-12.5	3.5/3.5	DP-4			
11						
12						
				0.0 ppm		
					Refusal @ 12.5' bgs	
13						

Exhibit 2-8

2007 SWMU 26 and SWMU 31 Boring Logs

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
331645.FO.05	BH-01	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Modine Manufacturing
LOCATION : Camdenton Missouri
ELEVATION :
DRILLING CONTRACTOR : IPS
DRILLING METHOD AND EQUIPMENT USED : DPT Geoprobe
LOGGER : G. Roberts
WATER LEVELS : None
START : 12/16/2007 1200 END : 12/16/2007 1235

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):	Breathing Zone	Sample Interval
					0.0' - CLAY (CH) brown, medium stiff to stiff, dry, gravel present	0.5	0	
	0-4	4/4	DPT		2.0' - Gravelly CLAY (GC), brown and tan, dry, unconsolidated clay and gravel	0.8		
						0.4		
5					4.0' - CLAY (CH), reddish brown, hard, dry, gravel present	0.4		
	4-8	4/4	DPT			0.3		
						0.8		
10	8-12	4/4	DPT					
				N/A		5.9		
15	12-16	4/4	DPT			19.1		
						24.8		
						12.4		
	16-20	4/4	DPT		18.0' - Clayey GRAVEL (GC), brown and tan, medium stiff, dry			
20					19.0' - SAND (SP), tan, loose, dry	14.8		
						4.6		
	20-22	2/2	DPT		21.0' - CLAY (CH), reddish brown, medium stiff, dry	25.8		MO-BH-01-21.0
					21.5' - Clayey SAND (SC), soft, dry			
					22.0' - Refusal on bedrock	20.1		MO-BH-01-22.0
25								

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
331645.FO.05	BH-02	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Modine Manufacturing
LOCATION : Camdenton Missouri
ELEVATION :
DRILLING CONTRACTOR : IPS
DRILLING METHOD AND EQUIPMENT USED : DPT Geoprobe
LOGGER : G. Roberts
WATER LEVELS : None
START : 12/16/2007 1340 END : 12/16/2007 1410

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone	Sample Interval
0					0.0' - CLAY (CH) brown and gray, medium stiff to stiff, dry, gravel present	0.4 0	
	0-4	4/4					
					3.0' - Gravelly CLAY (GC), brown and tan, dry, unconsolidated clay and gravel	0.4	
5					4.0' - Gravelly CLAY (GC), brown, unconsolidated to hard, dry	1.8	
	4-8	4/4				10.1	
						10.2	
					8.0' - CLAY (CH), reddish brown, hard, dry, gravel present	0.8	
10	8-12	4/4		N/A		32.5	
						18.2	
						14.5	
						12.8	
	12-16	4/4				8.1	
15					15.0' - GRAVEL, crushed limestone and chert	1.3	
					16.0' - CLAY (CH), reddish brown, medium stiff to stiff, dry, gravel present	1.4	
	16-20	4/4				8.2	
						52.4 @ 19.5	MO-BH-02-19.5
20					20.0' - CLAY (CH), reddish brown, medium stiff, dry	4.6	
	20-22	2/2			21.0' - Limestone fragments and rock flour	4.3	MO-BH-02-21.5
					22.0' - Refusal on bedrock		
25							

CH2MHILL

PROJECT NUMBER	BORING NUMBER		
331645.FO.05	BH-03	SHEET 1	OF 1

SOIL BORING LOG

PROJECT : Modine Manufacturing
LOCATION : Camdenton Missouri
ELEVATION :
DRILLING CONTRACTOR : IPS
DRILLING METHOD AND EQUIPMENT USED : DPT Geoprobe
LOGGER : G. Roberts
WATER LEVELS : None
START : 12/16/2007 1000
END : 12/16/2007 1050

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):	Breathing Zone	Sample Interval
					0.0' - CLAY (CH) brown and gray, medium stiff to stiff, dry, gravel present	1.5	0	
						2.4		
	0-4	4/4	DPT		2.0' - Gravelly CLAY (GC), brown and tan, dry, unconsolidated clay and gravel	1.8		
						1.3		
5						1.2		
						1.4		
	4-8	4/4	DPT		5.5' - CLAY (CH), brown and gray, stiff to hard, dry, gravel present	2		
					7.0' - Clayey GRAVEL (GC), reddish brown, dry, unconsolidated caly and gravel	1		
					8.0' - Clayey GRAVEL (GC), reddish brown, hard, dry	0.8		
						1.2		
10	8-12	4/4	DPT			1.5		
				N/A		3.8		
						2.4		
						5.6		
	12-16	4/4	DPT			10.2		
15						12.4		
						4.1		
	16-20	4/4	DPT			3.2		
						18.9		
20								
					20.0' - Silty CLAY (CL), reddish brown, medium stiff to stiff, dry, gravel present	20.4		
	20-22	2/2	DPT			5.6		
						15.2		
25								
						41.2		MO-BH-03-26.0
					28.0' - Limestone fragments and rock flour			MO-BH-03-28.0
30					30.0' - Refusal on bedrock	10.1		

CH2MHILL

PROJECT NUMBER	BORING NUMBER		
331645.FO.05	BH-04	SHEET 1	OF 1

SOIL BORING LOG

PROJECT : Modine Manufacturing
LOCATION : Camdenton Missouri
ELEVATION :
DRILLING CONTRACTOR : IPS
DRILLING METHOD AND EQUIPMENT USED : DPT Geoprobe
LOGGER : G. Roberts
WATER LEVELS : None
START : 12/16/2007 1145 END : 12/16/2007 1200

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone / Sample Interval
					0.0' - No recovery	0
	0-4	1/4	DPT			
				N/A	3.0' - Crushed limestone gravel	
5	4-8	3/4	DPT			
					8.0' - Refusal on concrete	
10						
15						
20						
25						

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
331645.FO.05	BH-05	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Modine Manufacturing
LOCATION : Camdenton Missouri
ELEVATION :
DRILLING CONTRACTOR : IPS
DRILLING METHOD AND EQUIPMENT USED : DPT Geoprobe
LOGGER : G. Roberts
WATER LEVELS : None
START : 12/16/2007 0900 END : 12/16/2007 0945

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone	Sample Interval
					0.0' - No recovery	0	
	0-4	1/4	DPT				
					3.0' - Silty CLAY (CL), brown, stiff, moist, gravel present		
5					4.0' - Clayey GRAVEL (GC), tan, dry, coarse	1.8	
	4-8	4/4	DPT	N/A	6.0' - CLAY (CH), reddish brown, hard, dry, gravel present		
						4.5	
					8.0' - CLAY (CH), brown and gray, medium stiff to hard, moist, gravel present	3.9	
						4.1	
10	8-12	4/4	DPT			4.6	MO-BH-05-10
						2.5	MO-BH-05-11.8
					12.0' - Refusal on bedrock		
15							
20							
25							

3. Findings from Previous Investigations

Previous investigations conducted by Dames & Moore, MDNR, CH2M HILL and SECOR were thoroughly discussed in the *Comprehensive historical summary document* (CH2M HILL 2005). This section presents a summary of previous investigations and corrective measures performed onsite and offsite.

Investigative activities at the Modine facility began in July 1992, when the MDNR Hazardous Waste Program Superfund Section installed two monitoring wells on the property (MW-1 west side, MW-2 east side) and collected groundwater samples from the wells along with neighboring private wells, surface water samples from a downgradient creek, and surface water samples from a nearby spring. The MDNR detected no chemicals in the water samples. Based on the results, the MDNR decided to pursue no further action, as documented in a letter to Modine dated March 2, 1993.

TCE first appeared at a concentration exceeding the maximum contaminant level (MCL) of 5 micrograms per liter (µg/L) in the onsite wells during the second MDNR sampling event in December 1994. Concentrations were only slightly above (5.1 and 6.9 µg/L) the MCL. TCE concentrations declined to below detectable levels in MW-2 in 1995 and 1996 but remained above the MCL in MW-1 through 1995 (two sampling events).

Based on the results obtained from MW-1 and MW-2, Modine installed two more wells in 1995 (MW-3 south, MW-4 north). Results from the sampling of the two wells indicated that the greatest concentrations were found in MW-4 about 125 feet northwest of the northwest corner of the plant. TCE concentrations there exceeded 100 µg/L in late 1995 and early 1996. Based on the direction of groundwater flow at the facility, MW-4 would be cross-gradient of an onsite source.

Modine undertook a fracture survey to better understand flow within the bedrock through secondary porosity. The findings suggest that the former Hulett Lagoon, one of five lagoons operated by the City of Camdenton to treat wastewater before construction of the City's publicly owned treatment works, was the likely source of elevated TCE concentrations in MW-4. Modine undertook an investigation in 1996 to determine the presence of volatile organics compounds (VOCs), in particular TCE, in soil within the confines of the former Hulett Lagoon. The investigation showed that TCE was present, and that it was the only VOC that exceeded the screening levels in use at the time.

Modine then installed MW-5 just outside the confines of the former lagoon in August 1998 to identify if groundwater contamination was present. TCE has been detected at MW-5 at concentrations above the MCL during each sampling event since the well was installed.

In 1998, TCE was detected in the City of Camdenton's Mulberry Well at concentrations in excess of the MCL of 5 µg/L. The Mulberry Well is located about 600 feet east-southeast of the Modine facility and 1,000 feet south of the former Hulett Lagoon.

In 1999, the MDNR conducted a membrane interface probe investigation and collected eight soil grab samples from the former Hulett Lagoon. There were no significant detections of

VOCs in the probes. TCE was detected in three soil samples collected near the previous location of the outfall pipe. The maximum concentration detected from the Hulett Lagoon was 9.5 mg/kg at boring location Hulett 01.

3.1 Offsite Investigations

In late 1999 or early 2000, HS took the lead in addressing offsite contamination from former operations at the facility, characterization of the former Hulett Lagoon, and characterization of the groundwater in the area of the Hulett Lagoon and the Modine facility under the cooperative agreement with the Superfund Section of MDNR. The investigative history regarding the former lagoon and groundwater is well documented in the RI report (SECOR 2003) and feasibility study report (SECOR 2004) produced by HS.

3.1.1 SWMU 1 Hulett Lagoon

HS conducted a soil investigation in areas of the lagoon that had not previously been investigated. Soil samples were analyzed in the field for TCE using a field gas chromatograph and the samples exhibiting the highest VOC concentrations were also submitted for Toxicity Characteristic Leaching Procedure analysis. No VOC concentrations were found at concentrations above the detection limits in the sample extract. One sample analyzed in the field with the gas chromatograph contained a detectable concentration for TCE. The fixed offsite laboratory TCE result for this sample (GP-9: 7 to 8 feet bgs) was 3.1 mg/kg. Figure 3-1 depicts the locations where soil samples were collected during the MDNR and HS investigations. MDNR acceptance of the RI provided concurrence with the conclusion that no risk is posed by residual soil contamination at the former Hulett lagoon. Therefore, the nature and extent, fate and transport, and potential risks associated with SWMU 1 (Hulett Lagoon) were not addressed as part of the RFI.

3.1.2 Area-wide Groundwater

The RI activities to address groundwater were conducted in three phases from 2000 through 2002. During the first phase, five monitoring wells were installed (MW-7 through MW-11). Four more wells (MW-12 through MW-15) were installed during Phase II. Seven more wells (MW-16 through MW-22) were installed as part of the third and final phase. At the request of MDNR, three wells (MW-23, MW-24 and MW-25) were installed in 2007 to further assess groundwater contamination in the deep and perched zones south of the Modine facility and northwest of the former lagoon.

Geophysical logging and pumping tests were conducted as part of the RI. An early discovery following Phase I and Phase II RI efforts was the identification of an aquitard (zone of lower relative permeability) 30 to 40 feet thick, the base of which is roughly 150 feet below ground at the Modine facility. The presence of the perched zone above the aquitard is discussed in the hydrogeology section of this report. Eight perched wells and 10 deep wells were installed during the RI and follow-up activities. Based on results of the RI, HS recommended that a feasibility study be performed to assess remedial alternatives and decide on a practical remedy to address groundwater impacts.

HS documented the following relevant findings from the groundwater RI and feasibility study reports:

- VOCs in groundwater are characterized and limited to TCE and cis-1,2-dichloroethene (cis-1,2-DCE). Note that cis-1,2-DCE is a degradation product of TCE.
- Most of the contaminant mass has accumulated in the perched zone; however, there are occasions during the year when no perched groundwater is present atop the low-permeability zone. The zone is not considered an aquifer since it neither permanently stores nor produces water in recoverable quantities sufficient for private or public use. Cross-sections depicting the potentiometric surface are presented as Figures 5-12 and 5-13 in the RI Report (SECOR 2000).
- The migration and extent of VOCs in both the deep and perched groundwater zones is strongly influenced by preferential flow pathways, including nearly vertical fractures and bedding plane separations.
- The City's removal of sediment from and closure of the former lagoon, and Modine's removal of affected soil on the west side of the manufacturing facility, eliminated sources for further contaminant migration to groundwater. Remaining affected soils in the area of the former lagoon and manufacturing facility are adequately addressed and do not pose a potential significant risk to human health and the environment.
- Groundwater in the perched zone does not pose a potential significant risk to human health.
- Active remediation of the perched zone is impractical. Since continuing sources of contamination in soil have been eliminated, natural attenuation likely will address contamination in the perched zone.
- Contamination can be contained through continued pumping of the Mulberry well. Limited additional studies, such as a remedial design, are needed to determine optimum pumping rates, appropriate monitoring locations, and potential equipment upgrades.

HS has continued to conduct quarterly groundwater sampling of both the shallow and deep wells in the area of the former lagoon and facility. Sample results are reported for TCE and cis-1,2-DCE in groundwater. The most recent data available are for 2007. The monitoring well locations and TCE and cis-1,2-DCE results from the 2007 quarterly sampling events are shown in Figure 3-3. The following are relevant results from 2007 (SECOR 2007):

- TCE concentrations were consistently above the MCL in perched wells MW-5, MW-8, MW-12 and MW-13, all of which are located near the former lagoon. The highest TCE and cis-1,2-DCE concentrations were present in perched well MW-25 (installed November 2007), immediately north of the former lagoon.
- TCE concentrations were consistently above the MCL in deep wells MW-14, MW-16, and MW-19. The wells are near or downgradient of the former lagoon.

As a precautionary measure, HS oversaw the abandonment of the Burnau well, a nonoperational, private well on Bentree Avenue. The depth of the well completion is unknown since well completion data are unavailable.

Since HS is taking the lead on groundwater investigation and remediation area-wide, the RFI did not and this RFI Report does not address the potential risks associated with contamination in groundwater.

3.1.3 Other Offsite Investigations

In 2006, MDNR conducted an investigation along the City of Camdenton sanitary sewer line between the Modine facility and the former lagoon. The findings are documented in the *Removal Action Sampling Report* (MDNR 2006a). Borings were advanced along the sewer line, and samples were collected and submitted for VOC analyses. The highest detection of TCE was 2.6 mg/kg from boring SB-03 at 21.0 feet below ground surface (bgs).

With MDNR concurrence, the nature and extent, fate and transport, and potential risks associated with contamination related to the city sanitary sewer line are not addressed as part of this RFI. However, it should be noted that MDNR reserved the right to address this issue at a future date, under a different program. The information is provided to allow for a complete picture of the work being conducted in the area as well as to demonstrate that TCE concentrations currently present in soil throughout the area are quite comparable in concentration.

3.2 Onsite Investigations

The following subsections summarize the scope and findings of previous investigations for each SWMU at the Modine facility recommended for further investigation by the VSI/PA (Jacobs 1992). These SWMUs are:

- SWMU 2 (Mudpits)
- SWMU 4 (Drum Storage Area 1)
- SWMU 5 (Drum Storage Area 2)
- SWMU 19 (Vapor Degreaser and Still M185)
- SWMU 31 (Drum Storage Area 3) and SWMU 26 (Monorail Vapor Degreaser and Still M567)

These SWMUs are no longer in use, and none are currently active. Therefore, the SWMUs are referred to herein as "former." Investigative activities at the Modine facility were conducted between 1992 and 2007 to assess the potential for releases from the SWMUs.

Figure 3-2 presents the locations of soil samples collected during previous investigation activities and analyzed to delineate the extent of contamination at the former SWMUs. The soil sample locations represent conditions for soils that remain in place (i.e., have not been excavated as part of a soil interim measure).

3.2.1 SWMU 2 (Former Mudpits)

The mudpits along the west side of the building were used for wastewater collection from the time of building construction in 1967 through 1986, when the wastewater pretreatment plant was constructed. There were originally four mudpits, identified as #1 to #4 from north to south. Mudpit #2 was removed during construction of the wastewater plant.

The mudpits were concrete sumps, each one a cube with dimensions of 4 feet to a side, located about 10 feet west of the building foundation. The mudpits received stormwater,

boiler blowdown, and cleaning line water from the manufacturing process. The mudpits were connected by a 6-inch steel line, and each received wastewater from the previous pit starting at the south (#4) and discharging to the onsite sewer line at the north (#1). The onsite wastewater discharge line conveyed wastewater from the former mud pits to the City of Camdenton sewer system located along the north side of the Modine facility.

3.2.1.1 Investigations and Interim Measures

An investigation was conducted in 1997 to assess potential releases from the mudpits. Ten soil probes were advanced adjacent to the mudpits and near the sewer line discharging to the north, and soil samples were collected from them and analyzed. Concentrations of lead were found to exceed the screening levels in place at that time. A soil removal action was conducted in October 1997 at Mudpits #1, #3, and #4 and the area surrounding the former probe location along the discharge line at the north end of Mudpit #1 to remediate the soils for lead. Figure 3-2 illustrates the limits of the excavations.

Confirmation samples from the excavation walls and floor of the mudpits showed that concentrations of VOCs and metals were below the historic screening levels in samples other than in the area of Mudpit #3. Lead was present in each wall, and the floor sample from this excavation. Additional excavation was not possible because of underground obstructions. Subsequent excavations at the facility revealed the occurrence of galena, a lead ore mineral, within the soil horizon. Therefore, it is likely that the elevated lead levels observed in the area are naturally occurring.

The onsite wastewater discharge line that connected the mudpits to the city sewer line was removed and replaced as part of a plant renovation in July 2000. Twelve composite soil samples were collected from both the floor and walls of the excavated trenches, and one sample was taken from the floor beneath a 90-degree elbow, resulting in a total of 25 soil samples. These samples were analyzed for VOCs and metals. One sample of released material, identified as sediment, was collected from each of the north-south and east-west segments of the discharge line. VOCs were detected in soil samples at concentrations below screening levels. Metals, with the exception of chromium and lead, were detected at concentrations below screening levels. Chromium concentrations in soil were elevated relative to the screening levels in use at the time in three samples: two nearest the former mudpits, and the other near a sediment release. Low concentrations of lead relative to the screening levels in use at the time were detected in four soil samples along the southernmost end of the discharge line. Sediment along the former onsite wastewater discharge line is no longer of concern since the source and the affected soil have been removed.

In 2006, at the request of the MDNR, two Geoprobe borings were completed, one each at Mudpits #1 and #3), located between the mudpit and the west wall of the manufacturing building. The purpose of the borings was to assess the extent of VOCs in soil that had been left in place following the excavation activities. VOC concentrations remaining in soil, though below applicable screening levels at the time, were above more recent screening levels. Borings to collect soil samples beneath the building were advanced to bedrock at an angle of 30 degrees from vertical, to assess the eastward lateral extent of potential soil contamination in these areas. Two soil samples were collected from each Geoprobe boring for the analysis of VOCs. The highest concentration of TCE from the Geoprobe soil samples was at a concentration of 3.4 mg/kg at 10 feet bgs. The maximum concentrations of tetrachloroethene

(PCE), cis-1,2-DCE, and trans-1,2-dichloroethene (trans-1,2-DCE) from the Geoprobe soil sampling were 1.9 E mg/kg, 0.0057 J mg/kg, and 0.12 mg/kg, respectively.

3.2.1.2 Chemicals Remaining in Soil

Metals remaining in soil, detected at concentrations in excess of historic screening levels, are lead and chromium. Neither metal was considered further in this RFI for the following reasons:

- Chromium concentrations are isolated and only slightly above the screening levels in use at the time the samples were taken. The source of the chromium in soil is thought to be the released sediment from the line, all of which has been removed.
- Lead levels found in soil are naturally occurring because of the presence of the lead-bearing ore galena.

VOCs remaining in site soil that are potentially related to SWMU 2 include TCE, PCE, cis-1,2-DCE, and trans-1, 2-DCE.

3.2.2 SWMU 4 (Former Drum Storage Area 1) and SWMU 5 (Former Drum Storage Area 2)

SWMU 4 (Drum Storage Area 1) was located about 80 feet west of the west wall of the current facility's mechanical room. Drum Storage Area 1 was operational from 1972 to 1983 and was an area roughly 25 by 30 feet in size. Up to 45 drums of liquid waste and sludge were stored in the area at any given time. Waste stored included TCE still bottoms, waste paint filters and liquid, and nonhazardous waste oil.

SWMU 5 (Drum Storage Area 2) was located about 10 feet west of the west wall of the building in an area now under the wastewater pretreatment plant. Drum Storage Area 2 was operational from 1983 through 1985. The storage area was constructed of a concrete slab (25 by 30 feet) with an 8-inch concrete containing curb for secondary containment. In addition to drum storage, the area also contained a 1,000-gallon capacity waste oil tank and a 5,300-gallon tank used to store TCE still bottom waste.

3.2.2.1 Investigations and Corrective Actions

The first investigation along the west side of the building was the 1991 environmental site assessment (ESA) conducted by Law Environmental, Inc., under contract to Modine. Part of the ESA investigation focused on what was identified as "Area 2, a drum storage area located along the west wall (side) of the plant." Four borings were advanced: two roughly 30 to 40 feet west of the plant building, one near the former location of a surface water drainage feature, and one along the assumed location of a buried stormwater drain line. Analytical results from soil samples collected from the borings indicated low levels of VOCs relative to the screening levels in use at the time.

A follow-up investigation was conducted in July 1993. Six soil borings were advanced and soil samples collected from within the area of the former drum storage area, to further assess the presence of VOCs, metals, and cyanide in soil. An additional background soil boring was advanced near the northeastern corner of the Modine property. Elevated lead

concentrations were found in one boring (B-11) located immediately south of the wastewater pretreatment area that overlies former Drum Storage Area 2.

A risk assessment was performed in 1994 to evaluate the risk posed by VOCs and lead in the former Drum Storage Area. The risk assessment concluded that no health risk was posed by the minimal amounts of VOCs in soil and that lead in soil was not considered a significant health risk. The MDNR disagreed with that conclusion.

In 1995, an investigation to achieve final closure of the interim RCRA TSD facility was implemented. The study included both an investigation to assess the extent of VOCs in the area of the former drum storage areas on the west side of the building and the remediation of the elevated lead level identified near boring B-11 in 1993. A groundwater investigation including the installation of wells MW-3 and MW-4 on the Modine facility was also part of the investigation. The elevated lead concentration detected near boring B-11 was present in the upper 2 feet of the soil horizon; therefore, the excavation extended to a depth of 3 feet below ground. Twelve cubic yards of soil were removed and, following characterization, disposed of offsite as a special waste. All confirmation samples from the floors and walls of the excavation contained lead concentrations below the background concentration.

During the 1995 investigation, six soil borings were advanced in an effort to define the lateral and vertical extent of the low VOC concentration previously identified. One sample, from boring B-13, exhibited elevated VOC concentrations with TCE found to exceed the historic screening level. Boring B-13 was located along the former buried stormwater drain line along the west side of the building.

A subsequent investigation was conducted to define the lateral extent of TCE contamination in soil surrounding former boring B-13 located near the end of the former stormwater drain line. The first phase of the investigation was conducted in October 2000 with four direct push soil probes being advanced near boring B-13. Based on the results of these borings, a second phase of the investigation was conducted in December 2000. Eight direct push soil probes were advanced. Seven probes were advanced around the borings advanced in October, each roughly 15 to 20 feet away from the original borings. The eighth probe was advanced down gradient of the area of interest. No elevated TCE concentrations were found. The highest concentration of vinyl chloride (VC) reported was an estimated value of 12 mg/kg which was subsequently removed during a corrective action measure.

A Corrective Action Work Plan was submitted and approved by MDNR in September 2001. The interim measures consisted of the excavation of soil impacted by VOCs on the west side of the Modine building defined based on the previous Phase 1 and 2 investigation results.

Excavation began in October 2001. As work progressed and more information regarding the historic handling of chlorinated solvents at the facility became available, it became apparent that the volume of affected soil was significantly more than had been estimated. This was particularly true laterally to the east and southeast of the assumed area of impact. Therefore, excavation ceased and a direct-push subsurface investigation was conducted to better define the extent of affected soil.

Thirty-four direct-push soil probes were advanced in November 2001 for this purpose. Borings were generally placed about 20 feet or more from areas of known impact identified during the excavation activities and advanced until probe refusal (bedrock) was

encountered. Site specific screening levels for cleanup also were calculated. If field results (photoionization detector readings, odor, discoloration) indicated that a boring was located within affected soil, that location was offset (typically by 20 feet) until the lateral extent was presumably defined. Soil samples were collected for VOC analysis at depths near the soil/bedrock interface from locations where field screening results indicated minimal impact. Excavation of the affected soil continued in an easterly direction to the assumed excavation limits identified during the direct push investigation. Excavation of the affected unconsolidated overburden continued until field screening indicated minimal VOC contamination existed or bedrock was encountered.

Confirmation samples were collected at approximate 10 linear foot intervals along the exposed excavation walls. Forty-nine confirmatory samples were collected. No confirmation samples were collected from the base of the excavation, since soils were removed down to the bedrock surface.

3.2.2.2 Chemicals Remaining in Soil

VOCs remaining in site soil potentially related to SWMU 4 and 5 are at concentrations below the calculated historic site specific screening levels. They include TCE, cis-1,2-DCE, and VC. In a letter dated June 30, 2004, MDNR concurred that the VOCs remaining in soil on the west side of the Modine facility require no further action, investigative or remedial.

3.2.3 SWMU 19 (Former Vapor Degreaser and Still M185)

SWMU 19 (Vapor Degreaser and Still M185) was located within the original and oldest part of the building near the west wall and was destroyed by a fire in July 1972. The VSI recommended further investigation based on the potential release of waste solvent onto the concrete floor during the fire, indicating that the waste solvent may have absorbed into the porous concrete floor. However, the floors were coated with concrete sealant, and the heat of the fire would have rapidly volatilized a release. Therefore, no investigation activities were ever implemented at SWMU 19.

3.2.4 SWMU 31 (Former Drum Storage Area 3) and SWMU 26 (Former Monorail Vapor Degreaser and Still M567)

SWMU 31 (Drum Storage Area 3) was located along the south wall of the building before the 1983 expansion. Following that expansion, SWMU 26 (the Monorail Vapor Degreaser and Still M567) were constructed in the same area. Therefore, SWMUs 31 and 26 are collocated in an area of interest now beneath the building floor.

Drum Storage Area 3 reportedly was operational from 1979 through 1983 (Jacobs 1992). It was located along the south outside wall of the building. The storage area was removed in 1983 to accommodate a building expansion to the south. The VSI/PA reports that Drum Storage Area 3 was constructed of a concrete slab over a base rock and clay mixture. It reportedly was 25 feet wide by 50 feet long. The VSI/PA reported that waste managed in the area consisted of waste TCE and waste oil from degreasing operations, stored in 55-gallon drums. A release of TCE from 15 corroded drums reportedly occurred there.

The Monorail Vapor Degreaser and Still M567 was the largest vapor degreaser at the facility. It was installed in 1985 and remained in service until 1997. The unit had a solvent

capacity of 4,000 gallons. The floor beneath the monorail vapor degreaser was recessed about 5.5 feet below the surface of the plant floor. The recessed trough was about 65 feet long (east to west) and 10 feet wide. The degreaser unit was about 50 feet long. TCE was used in the unit from 1985 until Modine purchased the facility in 1990. The building underwent a complete interior renovation in 1997. As part of that renovation, the degreasing units were removed and all recessed floor areas were brought to grade. Equipment and subgrade piping in the plant were replaced with new equipment and lines at this time.

Modine contends that the area was not used as a drum storage area for waste solvents but instead was used to store old equipment.

3.2.4.1 Investigations and Corrective Actions

The first investigation conducted at SWMU 31 and SWMU 26 was during the 1991 ESA. Part of the ESA investigation focused on what was identified as Area 1, a drum storage area south of the building wall, where MDNR has suggested that 4,500 gallons of solvent had been released. Five holes were drilled through the concrete floor, and hand-augered borings advanced, two of which were located within the monorail vapor degreaser trough.

Analyses of soil samples detected several VOCs; but only TCE and 1,1,1-trichloroethane (1,1,1-TCA) were found at concentrations above historic screening levels. TCE concentrations were elevated in the soil samples from the boring adjacent to the solvent tank (3.0 mg/kg) and at the east end of the degreaser trough (0.78 mg/kg). 1,1,1-TCA was detected at a concentration of 200 mg/kg in the soil sample from the east end of the trough.

Based on these findings, 10 soil probes were advanced in the area in April 1997. The probes were located on all sides of the trough and associated storage tank. The depths of the probes ranged from roughly 3.5 to 17 feet bgs. Soil analytical results indicated the highest VOC concentration in samples was collected from probe P-7, about 7 feet east of the aboveground solvent storage tank and 3 feet north of the trough for the monorail vapor degreaser. As part of the previous investigation in 1991, Law had installed an access port in the floor of the base of the degreaser trough for collecting water trapped within the gravel subgrade beneath the floor. A sample of trapped water was collected from the access port and from probe P-9 as part of the 1997 investigation. The analytical results from the trapped water samples indicated the presence of several VOCs. The trapped water from the access port contained methylene chloride, 1,1-dichloroethene (1,1-DCE), 1,2-DCA, 1,1,1-TCA, and TCE at concentrations above historic screening levels. The trapped water from probe P-9 contained concentrations of methylene chloride, 1,1-DCE, 1,1,1-TCA, and TCE at concentrations above historic screening levels. The concentrations in water samples collected from the access port were one to two orders of magnitude greater than those found in the trapped water samples from probe P-9.

MDNR was concerned about contaminant levels beneath the building floor related to the former degreaser area. As a result, in October 2006 a subsurface soil investigation was conducted to assess the extent of soil contaminated with chlorinated VOCs, primarily TCE, beneath the manufacturing building near the former Monorail Vapor Degreaser and Still M567. Five discrete soil samples were proposed to be collected during the horizontal drilling, but because of drilling constraints, only three could be collected. The three samples were analyzed for VOCs.

Soil samples were collected at the following locations as measured from the west wall of the Modine facility:

- 55 feet (MO-HB-055, about halfway between the Mudpits and the Monorail Vapor Degreaser, near the former still location).
- 85 feet (MO-HB-085, the northwest corner of the Monorail Vapor Degreaser, near the former solvent tank).
- 120 feet (MO-HB-120, near the center and immediately north of the area that housed the Monorail Vapor Degreaser). The soil sample was collected at 120 feet, rather than the proposed 115 feet, because of poor recovery at 115 feet.

Soil samples to be collected at depths of 150 and 185 feet were not collected, because gravel (crushed limestone) was encountered at 130 feet and continued to 160 feet (10 feet past the fourth proposed sampling location). The gravel encountered was the result of the decommissioning of the vapor degreaser pit, which included filling the pit with gravel.

Analytical results for the three soil samples (MO-HB-055, MO-HB-085, and MO-HB-120) from the horizontal boring revealed one sample with a TCE concentration above the screening level used for this investigation. Sample MO-HB-085 had a concentration at 0.69 mg/kg.

Since the 2006 investigation was unable to collect soil samples from the east end of the former Monorail Vapor Degreaser, the MDNR requested that additional soil samples be collected from that area. In December 2007, a skid-mounted direct push technology rig was used to advance soil probes in the area. Five direct push borings were advanced to bedrock or refusal in order to assess extent of contamination in this area. Analytical results indicated that TCE was present in soil immediately around the east end of the former degreaser at concentrations comparable to residual concentrations in soil from other onsite and offsite area (less than 4 mg/kg).

Groundwater perched within the unconsolidated zone at the bedrock surface was not encountered at the probe locations, so no groundwater samples could be collected.

3.2.4.2 Chemicals Remaining in Soil

VOCs remaining in site soil at concentrations above historic site specific screening levels potentially related to SWMUs 26 and 31 include 1,1-DCE, 1,1,1-TCA, and TCE.

3.2.5 Other Onsite Investigations

An Indoor Air Quality (IAQ) Assessment was conducted during March 2003 at the request of MDNR, to complete an Environmental Indicator (EI) determination for the Modine facility. The EI program is used by USEPA to track progress at sites under the RCRA Corrective Action Program.

Results from previous investigations indicated the possibility that residual chlorinated VOC concentrations below the site specific action levels could be present in the soil beneath the Modine facility. Thus, a potential pathway exists for contamination to migrate from residual VOCs in the soil to the air inside the plant. The objective of the IAQ assessment was to

investigate this potential pathway and determine if unacceptable human exposure to VOCs migrating to indoor air from soil was occurring at the facility.

The use of the Johnson and Ettinger model (USEPA 2000) was originally proposed to make the EI determination. However, direct measurement was considered to be a more appropriate method for evaluating the potential exposure pathways and, with the concurrence of MDNR, indoor air sampling was performed to evaluate potential human exposure pathways at the facility related to VOC migration from soil.

A pre-sampling assessment of the facility was conducted to determine the most appropriate sampling locations. The assessment consisted of a review of facility plans and an interview with Modine plant management to delineate areas of interest for air sampling within the Modine plant. The assessment differentiated specific areas of the plant based on separate heating, ventilation, and air conditioning systems, plant construction and renovation details, equipment locations and current usage of plant areas.

Sample locations were selected where a higher potential was assumed to exist for air transfer between the soil beneath the building and the indoor air (i.e., areas where floor breaches occur), and where prior activities at the facility may have caused subsurface contamination. Additionally, at least one sample was collected in each of the three separate heating, ventilation, and air conditioning system service areas at the plant.

Results were compared to 1 percent of the Occupational Safety and Health Administration (OSHA) standard for protection of worker health. At the request of MDNR, risk-based screening levels for a worker exposure scenario were also used for comparison purposes.

As agreed upon with MDNR, air samples were collected from six locations within the Modine facility and one outside of the facility. One duplicate sample and one blank sample were also collected. Air sampling locations are identified below and shown on Figure 3-4. Samples were analyzed for 1,1-DCA, 1,1-DCE, cis-1,2-DCE, methylene chloride, trans-1,2-DCE, PCE, 1,1,1-TCA, TCE, and VC.

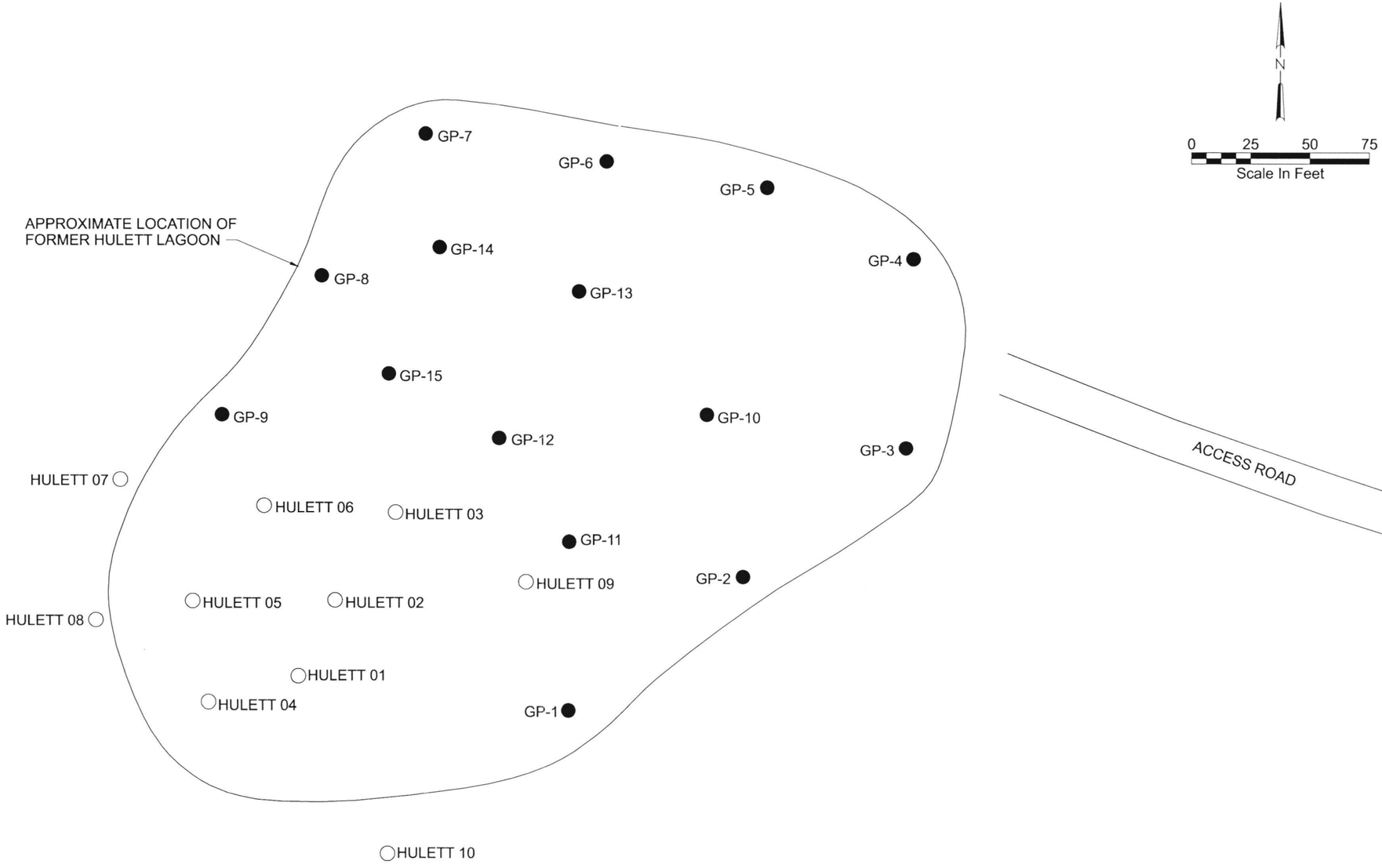
The IAQ Assessment sampling attempted to approximate potential worst-case conditions for the soil to indoor air exposure pathway. The state of Massachusetts (MADEP 2002) has identified some generic conditions under which greater vapor migration from soil or groundwater may occur. These conditions are:

- Highest potential for vapor migration is during late winter/early spring
- Indoor temperatures are 10 degrees Fahrenheit greater than outdoor temperatures
- Winds greater than 5 miles per hour
- Soils around the building saturated by precipitation
- Mechanical heating system in operation
- Mechanical fans off and doors and windows closed

An attempt was made to conduct the IAQ assessment under conditions when significant vapor migration from soil could be expected to occur.

Low concentrations of five chemicals of potential concern (COPCs) (TCE, PCE, cis-1,2-DCE, VC, and methylene chloride) were detected in the indoor air samples. TCE and PCE were detected in samples from each of the six indoor locations. The maximum detected TCE concentration was 61.5 parts per billion by volume (ppbv) in sample MD-AS-02 collected near the northwest corner of the building behind the women's restroom where floor breaches (piping and drains) occur. The maximum detected PCE concentration was 0.602 ppbv in sample MD-AS-05 collected near the welding bays in the center of the plant. Detectable concentrations of cis-1,2-DCE were present in two of the six samples. Both reported detections were flagged as estimated values and concentrations were below 1 ppbv. VC and methylene chloride were detected in three of the six samples, but not in the same samples. None of the VC concentrations exceeded 0.015 ppbv. The maximum detected methylene chloride concentration was 1.13 ppbv in sample MD-AS-01 collected in the main conference room of the office wing located at the northeast corner of the building. The duplicate sample, MD-AS-08, was submitted blind to the laboratory. Analytical results corroborated those of MD-AS-05.

TCE and PCE were detected at very low concentrations in the outdoor air sample. TCE and PCE concentrations were 0.204 ppbv and 0.053 ppbv, respectively. A detection of TCE, at 0.025 ppbv, was present in the blank sample, MD-AS-B1. This result was noticeably higher than the precertification value for the sampling canister.



LEGEND

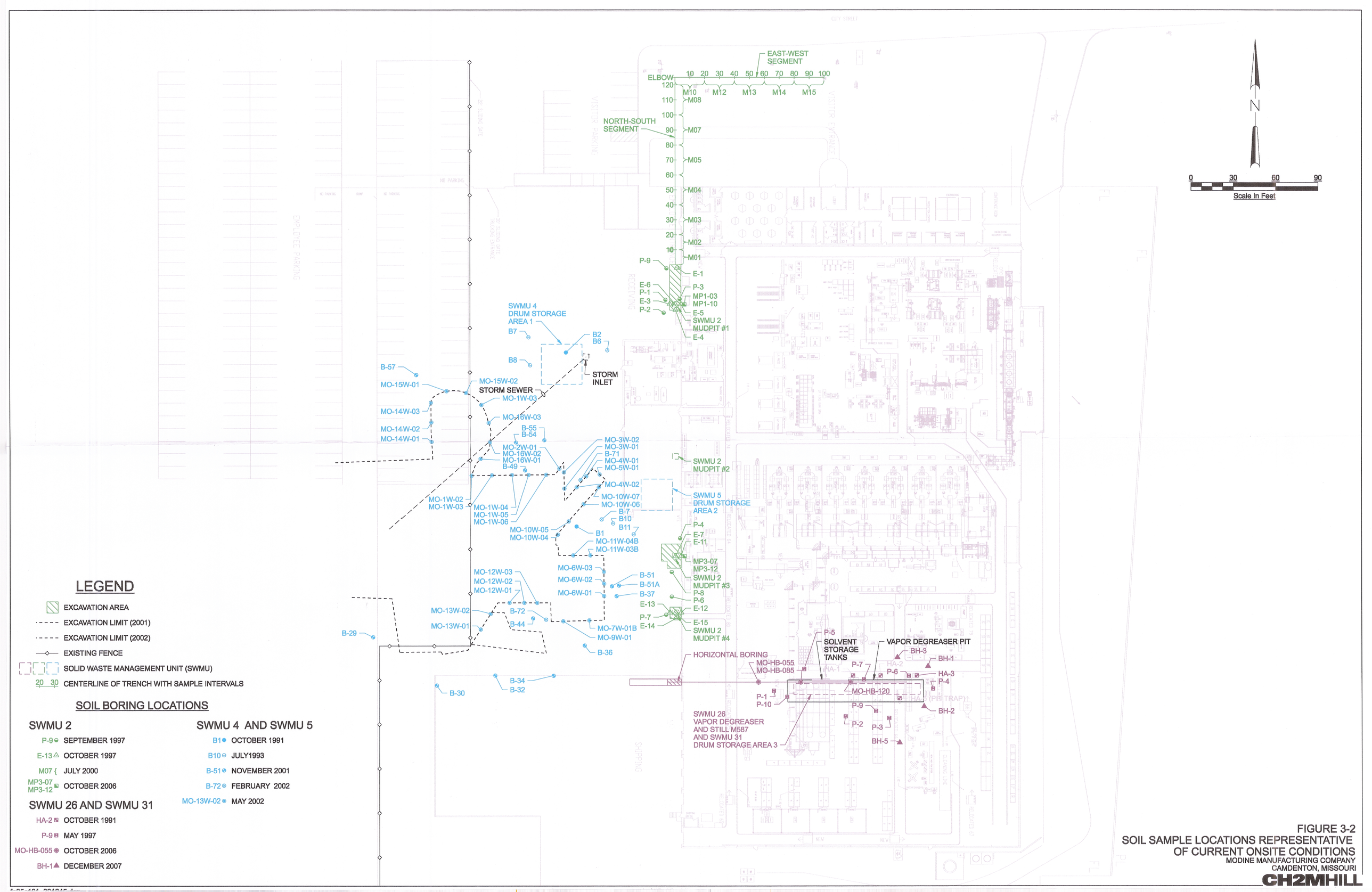
GP-3● SECOR SOIL BORING LOCATION, JUNE 2000

HULETT 08○ MDNR SOIL BORING LOCATION, JANUARY 1999

FIGURE 3-1
HULETT LAGOON SOIL SAMPLE LOCATIONS
MODINE MANUFACTURING COMPANY
CAMDENTON, MISSOURI

CH2MHILL

fn05c104_331645.dgn



LEGEND

- EXCAVATION AREA
- EXCAVATION LIMIT (2001)
- EXCAVATION LIMIT (2002)
- EXISTING FENCE
- SOLID WASTE MANAGEMENT UNIT (SWMU)
- 20 30 CENTERLINE OF TRENCH WITH SAMPLE INTERVALS

SOIL BORING LOCATIONS

SWMU 2

- P-9 SEPTEMBER 1997
- E-13 OCTOBER 1997
- M07 JULY 2000
- MP3-07 MP3-12 OCTOBER 2006

SWMU 26 AND SWMU 31

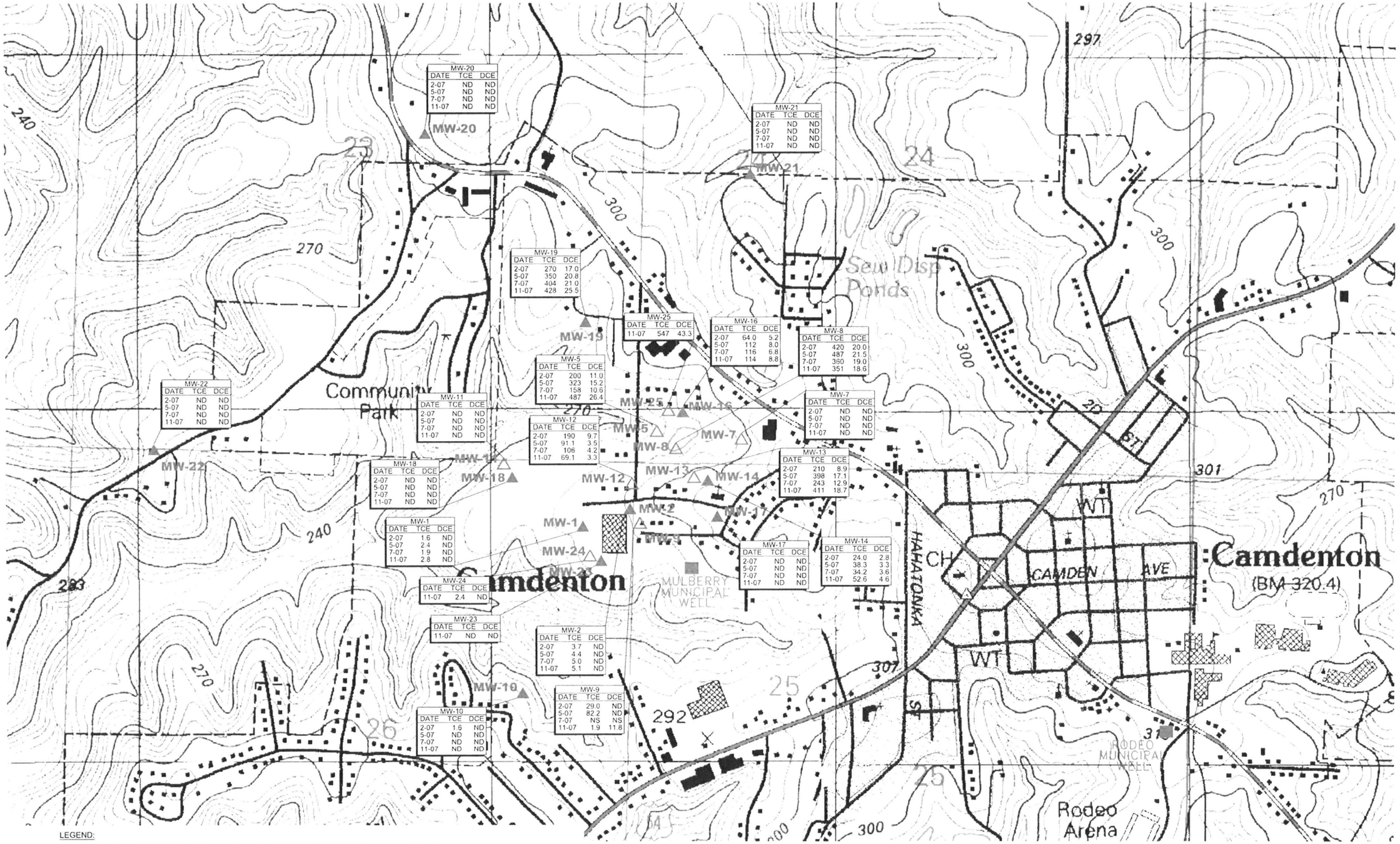
- HA-2 OCTOBER 1991
- P-9 MAY 1997
- MO-HB-055 OCTOBER 2006
- BH-1 DECEMBER 2007

SWMU 4 AND SWMU 5

- B1 OCTOBER 1991
- B10 JULY1993
- B-51 NOVEMBER 2001
- B-72 FEBRUARY 2002
- MO-13W-02 MAY 2002

FIGURE 3-2
SOIL SAMPLE LOCATIONS REPRESENTATIVE OF CURRENT ONSITE CONDITIONS
MODINE MANUFACTURING COMPANY
CAMDENTON, MISSOURI

CH2MHILL



LEGEND:

- △ MONITORING WELL LOCATION (SHALLOW)
- ▲ MONITORING WELL LOCATION (DEEP)
- ■ MUNICIPAL WELL LOCATION
- 10 FEET ELEVATION CONTOUR

- ND NO CONTAMINATION DETECTED
- NS NOT SAMPLED
- NA NOT AVAILABLE
- TCE TRICHLOROETHYLENE
- DCE CIS 1-2-DICHLOROETHYLENE

MW-18 ▲ DEEP WELL
MW-12 △ SHALLOW WELL
EXISTING MONITORING WELL LOCATION

NOTE: ANALYTICAL MEASUREMENTS ARE µg/L

N

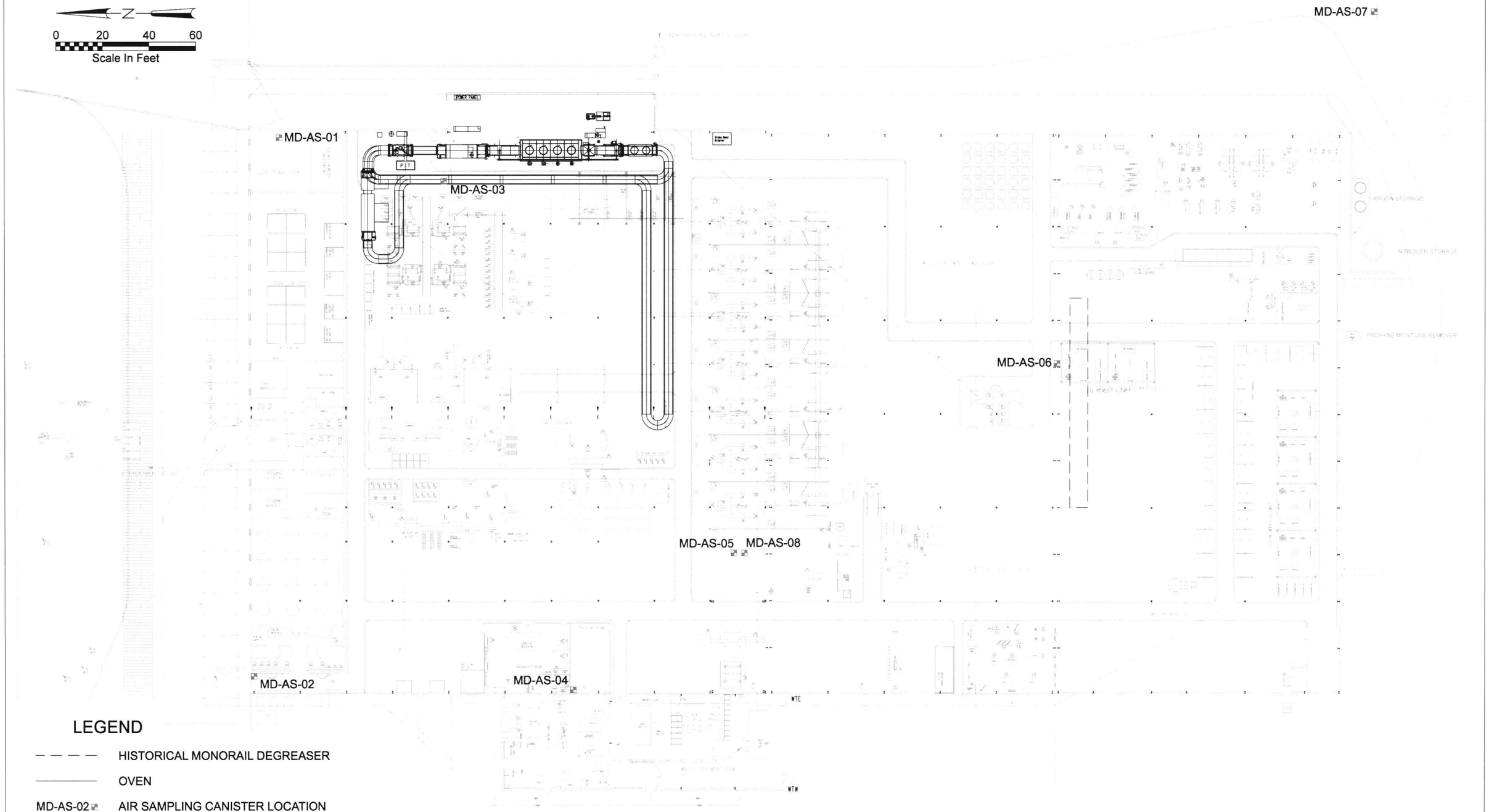
NTS

FIGURED DEVELOPED FROM INFORMATION PROVIDED BY :
ENGINEER: SECOR
FIGURE NAME: GROUNDWATER ANALYTICAL RESULTS FOR THE "PERCHED ZONE" AND "DEEP AQUIFER"
DATE: 11/29/07

FIGURE 3-3
TCE AND CIS-1,2-DCE RESULTS IN GROUNDWATER
MODINE MANUFACTURING COMPANY
CAMDENTON, MISSOURI

CH2MHILL

fn05c105_331645.dgn



LEGEND

- HISTORICAL MONORAIL DEGREASER
- OVEN
- MD-AS-02 AIR SAMPLING CANISTER LOCATION

FIGURE 3-4
INDOOR AIR SAMPLING LOCATIONS
MODINE MANUFACTURING COMPANY
CAMDENTON, MISSOURI

CH2MHILL

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4. Nature and Extent of Contamination

This section discusses the nature and extent of contamination remaining in soil at the Modine facility. Based on the results and evaluation of the previous investigations conducted at the facility (as presented in Section 3), the following VOCs remaining in soil at the site were identified as possible chemicals of potential concern: 1,1-DCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,1-TCA, 1,1,2-trichloroethane (1,1,2-TCA), TCE, and VC. These chemicals were detected in soil during past investigations. Risk-based screening levels were defined for each COPC, for the purpose of discussing the nature and extent of contamination at the site.

4.1 Screening Levels

4.1.1 Soil

USEPA's Region 6 Human Health Medium-Specific Screening Levels (MSSLs) for an industrial worker (USEPA Region 6 2007) were used for the purpose of screening soil as meeting the definition of "contaminated" or "not contaminated." MSSLs are based on a target risk level of 1×10^{-6} for carcinogens and a hazard quotient (HQ) of 1 for noncarcinogens. MSSLs based on noncarcinogenic effects were adjusted using a HQ of 0.1 to account for potential additive effects. After the adjustment was made, indoor worker and outdoor worker MSSLs were compared, and the lower of the two was selected as the soil risk-based screening values (RBSVs). MSSLs are presented in Table 4-1.

Following the 2006 investigation at SWMUs 26 and 31, the MDNR and Modine had agreed to a TCE concentration suitable for defining extent of contamination at the site: 4 mg/kg. That level was based upon TCE concentrations present in both onsite and offsite soil which are the same order of magnitude and comparable in concentration.

4.1.2 Indoor Air

The current guidance for preparing EI determinations is the USEPA *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (USEPA 2002a). The guidance was developed for use in residential settings and contains no specific methodology or screening levels for evaluating potential vapor intrusion pathways in workplaces. USEPA does not expect this guidance to be used for settings that are primarily occupational. The draft guidance states that OSHA and USEPA have agreed that OSHA generally will take the lead role in addressing occupational exposures since workers will generally understand the workplace (e.g., OSHA) regulations (and monitoring, as needed) that already apply and are provided for their protection.

Consequently, the EI determination for the indoor air pathway in workplaces typically is based on comparison of indoor air sampling results to occupational standards. OSHA establishes Permissible Exposure Limits (PELs) as their screening level for workplace exposures based on an 8-hour time weighted average concentration. The screening levels

include the lower value from the following sources for comparison to the indoor air results and to demonstrate achievement of the EI:

- Regulatory established OSHA PELs
- Guidance exposure limits established by National Institute of Occupational Safety and Health (NIOSH)—Recommended Exposure Levels (RELs)
- Guidance exposure limits established by the American Conference of Governmental Industrial Hygienists (ACGIH)—Threshold Limit Values (TLVs)

USEPA has indicated that the applicability and use of the occupational values is a risk management decision.

In addition, at the request of MDNR as part of the EI Determination, risk-based screening levels were calculated using a worker exposure scenario in accordance with USEPA's *Risk Assessment Guidance for Superfund, Volume 1 - Human Health Evaluation Manual - Supplemental Guidance: Standard Exposure Factors* (USEPA 1991). A target excess lifetime cancer risk (ELCR) of 1×10^{-4} and a target non-cancer HQ of 1.0 were used to calculate screening levels for an industrial worker exposure scenario using the following input parameters specified below. These calculated risk-based concentrations were not used in this RFI to evaluate the nature and extent of indoor air impacts; rather, occupational-based values (indicated above) were used. The calculated risk-based concentrations were used to evaluate potential human health risks.

- Exposed Population—Adults only
- Average Body weight—70 kilograms
- Inhalation Rate of 1 cubic meter per hour based on activities conducted at the facility being classified as light to moderate activity level in accordance with USEPA's *Exposure Factors Handbook* (USEPA 1997)
- Exposure time of 9 hours per day based on an 8-hour work day, 0.5-hour lunch break, and 0.25 hours on either side of clocking in and out.
- Exposure frequency of 250 days per year (5 days per week - 50 weeks per year)
- Exposure duration of 25 years

4.2 Identification and Distribution of Chemicals in Excess of Screening Levels

4.2.1 Soil

Table 4-1 lists soil analytical results representative of current onsite conditions. TCE is the only chemical of the VOC screening list that exceeds the MSSL. The distribution across the site of TCE that exceeds the soil MSSL is illustrated in Figure 4-1. The distribution of TCE remaining in soil at the site is discussed by SWMU below:

- **SWMU 2 (Former Mudpits)**—TCE is present at concentrations exceeding the MSSL in 13 samples from 12 locations associated with the former mudpits and sanitary sewer discharge line from the mudpits. Concentrations of TCE exceeding the 0.092 mg/kg MSSL range from 0.11 to 4 mg/kg (Figure 4-1). Most of the TCE concentrations exceeding the MSSL occur along the east side of former Mudpits #1, #3 and #4 immediately adjacent to or beneath the building foundation and floor. The extent of the TCE in soil at SWMU 2 as a result of past activities is delineated to the acceptable level of 4 mg/kg.
- **SWMU 4 (Former Drum Storage Area 1) and SWMU 5 (Former Drum Storage Area 2)**—Concentrations of TCE in soil on the west side of building in the area of SWMUs 4 and 5 are below the MSSL (Table 4-1). The results demonstrate that the soil corrective action adequately remediated the soil contamination in this area.
- **SWMU 31 (Former Drum Storage Area 3) and SWMU 26 (Former Monorail Vapor Degreaser and Still M567)**—While multiple COPCs were detected in one or more of the soil samples collected at SWMUs 31 and 26 (Table 4-1), TCE was the only chemical detected at a concentration above the MSSL in the soil samples collected from beneath the building. TCE was present at concentrations above the MSSL in 12 samples collected from 8 locations (Figure 4-1). TCE is limited to an area slightly larger than the former footprint of the Monorail Vapor Degreaser trough. TCE concentrations decrease with distance from the former trough. The extent of TCE contamination is delineated to the acceptable level of 4 mg/kg.

4.2.2 Indoor Air

Table 4-2 lists indoor air analytical results from the Indoor Air Quality Assessment conducted during March 2003. None of the VOCs sampled exceed the OSHA PELs. Concentrations of the five VOCs detected in indoor air samples from the Modine facility were well below (less than 1 percent of) the lowest available occupational exposure level. . The detected concentrations in indoor air at the facility are also below the calculated screening levels for workers in an industrial setting. Table 4-2 provides a comparison of the VOCs detected versus both calculated risk-based screening levels and published occupational exposure limits for a worker exposure scenario.

TABLE 4-1

Soil Analytical Results Representative of Current Onsite Conditions

Modine Manufacturing Company, Camdenton, Missour.

			SWMU 2																		
		Sample ID	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	E-1	E-3	E-4	E-5	E-6	E-7	E-11	E-12	E-13	E-14	E-15
		Date	9/3/1997	9/3/1997	9/3/1997	9/3/1997	9/3/1997	9/3/1997	9/3/1997	9/3/1997	9/3/1997	10/2/1997	10/2/1997	10/2/1997	10/2/1997	10/2/1997	10/2/1997	10/2/1997	10/2/1997	10/2/1997	10/2/1997	10/2/1997
		Sample Depth (ft bgs)	8-10	0-4	4-7	8-10	0-4	4-8	0-4	0-4	4-6	7	8-10	8-10	8-10	8-10	11.5	11.5	8	8	8	8
VOCs	Units	CASRN	Screening Level																			
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	0.002 U	0.002 U	0.002 U	0.002 U	**0.006**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.01 U	0.002 U	0.002 U	0.002 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	0.002 U	0.002 U	0.002 U	0.002 U	**0.007**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.01 U	0.002 U	0.002 U	0.002 U
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	**0.077**	**0.004**	0.002 U	**0.069**	NA	**0.015**	**0.014**	**0.021**	**0.108**	**0.21**	**0.01**	**0.008**	0.002 U	**0.235**	**0.075**	**0.19**	**0.43**	0.002 U	**0.122**	**0.069**
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	0.002 U	0.002 U	0.002 U	0.002 U	NA	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.01 U	0.002 U	0.002 U	0.002 U
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	0.002 U	0.002 U	0.002 U	0.002 U	0.005 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.01 U	0.002 U	**0.451**	0.002 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	0.002 U	0.002 U	0.002 U	0.002 U	0.005 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.01 U	0.002 U	0.002 U	0.002 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.002 U	0.002 U	0.002 U	0.002 U	0.005 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.01 U	0.002 U	0.002 U	0.002 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	**0.059**	**0.07**	**0.003**	**0.19**	**0.05**	**0.09**	**0.018**	**0.032**	**0.123**	**0.064**	**0.276**	**0.275**	**0.011**	**0.925**	**0.375**	**0.175**	**1.975**	0.002 U	**0.256**	**0.383**
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.002 U	0.002 U	0.002 U	0.002 U	0.01 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.01 U	0.002 U	0.002 U	0.002 U

			SWMU 2				
		Sample ID	MP1-03	MP1-10	MP1-10FD	MP3-07	MP3-12
		Date	Oct 2006	Oct 2006	Oct 2006	Oct 2006	Oct 2006
		Sample Depth (ft bgs)	3	10	10	7	12
VOCs	Units	CASRN	Screening Level				
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	0.0057 U	0.0059U	U	0.007 U	0.0051 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	0.0057U	**0.0013 J**	**0.0072 J**	**0.0026 J**	**0.00063 J**
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	**0.096**	**1.0**	**0.750 E**	**1.9 E**	**0.12**
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	0.0057 U	**0.0057 J**	**0.0037 J**	**0.0027 J**	0.0051 U
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	**0.017**	**0.12**	**0.11**	0.007 U	0.0051 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	0.0057 U	0.0059 U	U	0.007 U	0.0051 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.0057 U	0.0026 J	0.0021 J	0.007 U	0.0051 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	**0.11**	**3.4**	**1.500 E**	**0.0021 J**	**0.56**
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.0031 J	0.0068	0.0030 J	**0.062**	0.0051 U

			Downgradient of SWMU 2 - Onsite Sewer Line																		
		Sample ID	M01B	M01W	M02B	M02W	M03B	M03W	M04B	M04W	M05B	M05W	M07B	M07W	M08B	M08W	M09E	M10B	M10W	M12B	M12W
		Date	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/25/2000	7/26/2000	7/26/2000	7/26/2000	7/26/2000
		Sample Depth (ft bgs)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
VOCs	Units	CASRN	Screening Level																		
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	0.0072 U	0.0074 U	0.0068 U	0.0066 U	0.0061 U	0.0057 U	0.0065 U	0.0055 U	0.0059 U	0.0065 U	0.0062 U	0.0058 U	0.006 U	0.0059 U	0.0064 U	0.0059 U	0.006 U	0.0062 U	0.0057 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	0.0072 U	0.0074 U	0.0068 U	0.0066 U	0.0061 U	0.0057 U	0.0065 U	0.0055 U	0.0059 U	0.0065 U	0.0062 U	0.0058 U	0.006 U	0.0059 U	0.0064 U	0.0059 U	0.006 U	0.0062 U	0.0057 U
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	0.0072 U	0.0074 U	0.0068 U	0.0066 U	0.0061 U	0.0057 U	0.0065 U	0.0055 U	0.0059 U	0.0065 U	0.0062 U	0.0058 U	0.006 U	0.0059 U	0.0064 U	0.0059 U	0.006 U	0.0062 U	0.0057 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	0.0072 U	0.0074 U	0.0068 U	0.0066 U	0.0061 U	0.0057 U	0.0065 U	0.0055 U	0.0059 U	0.0065 U	0.0062 U	0.0058 U	0.006 U	0.0059 U	0.0064 U	0.0059 U	0.006 U	0.0062 U	0.0057 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.0072 U	0.0074 U	0.0068 U	0.0066 U	0.0061 U	0.0057 U	0.0065 U	0.0055 U	0.0059 U	0.0065 U	0.0062 U	0.0058 U	0.006 U	0.0059 U	0.0064 U	0.0059 U	0.006 U	0.0062 U	0.0057 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	0.0072 U	0.0074 U	0.0068 U	0.0066 U	0.0061 U	0.0057 U	0.0065 U	0.0055 U	0.0059 U	0.0065 U	0.0062 U	0.0058 U	0.006 U	0.0059 U	0.0064 U	0.0059 U	0.006 U	0.0062 U	0.0057 U
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.0072 U	0.0074 U	0.0068 U	0.0066 U	0.0061 U	0.0057 U	0.0065 U	0.0055 U	0.0059 U	0.0065 U	0.0062 U	0.0058 U	0.006 U	0.0059 U	0.0064 U	0.0059 U	0.006 U	0.0062 U	0.0057 U

			Downgradient of SWMU 2 - Onsite Sewer Line					
		Sample ID	M13B	M13W	M14B	M14W	M15B	M15W
		Date	7/26/2000	7/26/2000	7/26/2000	7/26/2000	7/26/2000	7/26/2000
		Sample Depth (ft bgs)	3	3	3	3	3	3
VOCs	Units	CASRN	Screening Level					
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	0.0066 U	0.006 U	0.0063 U	0.007 U	0.0071 U	0.0068 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	0.0066 U	0.006 U	0.0063 U	0.007 U	0.0071 U	0.0068 U
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	NA	NA	NA	NA	NA	NA
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	0.0066 U	0.006 U	0.0063 U	0.007 U	0.0071 U	0.0068 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	0.0066 U	0.006 U	0.0063 U	0.007 U	0.0071 U	0.0068 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.0066 U	0.006 U	0.0063 U	0.007 U	0.0071 U	0.0068 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	0.0066 U	0.006 U	0.0063 U	0.033	0.0071 U	0.0068 U
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.0066 U	0.006 U	0.0063 U	0.007 U	0.0071 U	0.0068 U

TABLE 4-1
Soil Analytical Results Representative of Current Onsite Conditions
Modine Manufacturing Company, Camdenton, Missouri

SWMU 4 and SWMU 5

			Sample ID	B-1	B-2	B-6	B-7	B-8	B-10	B-11	B-29	B-30	B-32	B-34	B-34D	B-36	B-37	B-40	B-49	B-51A	B-54	B-57	B-57D	B-70	B-71
			Date	10/8/1991	10/8/1991	7/7/1993	7/7/1993	7/7/1993	7/7/1993	7/7/1993	11/12/2001	11/12/2001	11/12/2001	11/12/2001	11/12/2001	11/12/2001	11/12/2001	11/12/2001	11/13/2001	11/13/2001	11/13/2001	11/13/2001	11/13/2001	11/13/2007	2/13/2002	2/13/2002
			Sample Depth (ft bgs)	2.0-4.0	2.0-4.3	3	1	3	3	1	6-8	8-10	5-7	3.5-5.5	3.5-5.5	2.5-4.5	0-1.5	3.5-5.5	10.5-12.5	0.5-2.5	7.5-9.5	5.5-7.5	5.5-7.5	7-8	6-7
VOCs	**Units**	**CASRN**	**Screening Level**																						
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	**0.0062**	0.00043 U	0.0013 U	0.0011 U	0.0012 U	0.001 U	0.0013 U	0.0061 U	0.0054 U	0.006 U	0.0059 U	0.0065 U	0.006 U	0.0065 U	0.0057 U	0.0054 U	0.0059 U	0.0058 U	0.0062 U	0.0059 U	0.029 U	0.0054 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	0.0019 U	0.0019 U	0.0013 U	0.0011 U	0.0012 U	0.001 U	0.0013 U	0.0061 U	0.0054 U	**0.006**	0.0059 U	0.0065 U	0.006 U	0.0065 U	0.0057 U	0.0054 U	0.0059 U	0.0058 U	0.0062 U	0.0059 U	0.029 U	0.0054 U
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	NA	NA	NA	NA	NA	NA	NA	0.0061 U	0.0054 U	**0.157**	**0.863**	**0.916**	**0.120**	**1.01**	**1.01**	0.0054 U	**0.046**	0.0058 U	**0.021**	**0.038**	**0.738**	0.0054 U
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	0.0014 U	0.0014 U	0.0013 U	0.0011 U	0.0012 U	0.001 U	0.0013 U	0.0061 U	0.0054 U	0.006 U	0.0059 U	**0.0072**	0.006 U	0.0075	0.0057 U	0.0054 U	0.0059 U	0.0058 U	0.0062 U	0.0059 U	0.029 U	0.0054 U
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	**0.0058**	0.00043 U	0.0013 U	0.0011 U	0.0012 U	0.001 U	0.0013 U	0.0061 U	0.0054 U	0.006 U	0.0059 U	0.0065 U	0.006 U	0.0065 U	0.0057 U	0.0054 U	0.0059 U	0.0058 U	0.0062 U	0.0059 U	0.029 U	0.0054 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	**0.16**	**0.0012**	0.0023 U	0.002 U	0.0022 U	0.0018 U	0.0023 U	0.0061 U	0.0054 U	0.006 U	0.0059 U	0.0065 U	0.006 U	0.0065 U	0.0057 U	0.0054 U	0.0059 U	0.0058 U	0.0062 U	0.0059 U	0.029 U	0.0054 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.00029 U	0.00029 U	0.0013 U	0.0011 U	0.0012 U	0.001 U	0.0013 U	0.0061 U	0.0054 U	0.006 U	0.0059 U	0.0065 U	0.006 U	0.0065 U	0.0057 U	0.0054 U	0.0059 U	0.0058 U	0.0062 U	0.0059 U	0.029 U	0.0054 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	**0.061**	0.0017 U	0.0013 U	0.0011 U	0.0012 U	0.001 U	0.0013 U	0.0061 U	0.0054 U	0.006 U	0.0059 U	0.0065 U	0.006 U	0.0065 U	0.0057 U	0.0054 U	0.0059 U	0.0058 U	0.0062 U	0.0059 U	0.068 U	0.0054 U
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.0026 U	0.0026 U	0.0026 U	0.0022 U	0.0024 U	0.002 U	0.0026 U	0.0061 U	0.0054 U	**0.012**	**0.025**	**0.033**	**0.011**	**0.120**	0.0057 U	0.0054 U	**0.037**	0.0058 U	**0.040**	**0.064**	0.029 U	0.0054 U

SWMU 4 and SWMU 5

			Sample ID	B-72	MO-1W-02	M0-1W-03	MO-1W-04	MO-1W-05	MO-1W-06	MO-2W-01	MO-3W-01	MO-3W-02	MO-4W-01	MO-4W-02	MO-5W-01	MO-6W-01	MO-6W-02	MO-6W-03	MO-7W-1B	MO-9W-01	MO-10W-04	MO-10W-05	MO-10W-06
			Date	2/13/2002	5/20/2002	5/20/2002	5/20/2002	5/20/2002	5/20/2002	5/29/2002	5/29/2002	5/29/2002	5/29/2002	5/29/2002	5/29/2002	5/28/2002	5/28/2002	5/28/2002	6/3/2002	5/28/2002	5/15/2002	5/29/2002	5/29/2002
			Sample Depth (ft bgs)	5-7	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
VOCs	**Units**	**CASRN**	**Screening Level**																				
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	0.028 U	0.03 U	0.032 U	0.034 U	0.034 U	0.032 U	0.031 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.032 U	0.029 U	0.03 U	0.034 U	0.03 U	0.031 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	0.028 U	0.03 U	0.032 U	0.034 U	0.034 U	0.032 U	0.031 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.032 U	0.029 U	0.03 U	0.034 U	0.03 U	0.031 U
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	**0.111**	**1.000**	0.032 U	0.034 U	0.034 U	**0.401**	**0.490**	**0.409**	**0.211**	**0.110**	**1.140**	**0.590**	**0.065**	**0.361**	0.032 U	0.029 U	**1.190**	0.034 U	0.03 U	**3.420**
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	0.028 U	0.03 U	0.032 U	0.034 U	0.034 U	0.032 U	0.031 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.032 U	0.029 U	0.03 U	0.034 U	0.03 U	0.031 U
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	0.028 U	0.03 U	0.032 U	0.034 U	0.034 U	0.032 U	0.031 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.032 U	0.029 U	0.03 U	0.034 U	0.03 U	0.031 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	0.028 U	0.03 U	0.032 U	0.034 U	0.034 U	0.032 U	0.031 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.032 U	0.029 U	0.03 U	0.034 U	0.03 U	0.031 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.028 U	0.03 U	0.032 U	0.034 U	0.034 U	0.032 U	0.031 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.032 U	0.029 U	0.03 U	0.034 U	0.03 U	0.031 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	0.028 U	0.03 U	0.032 U	0.034 U	0.034 U	0.032 U	0.031 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.032 U	0.029 U	0.03 U	0.034 U	0.03 U	0.031 U
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.028 U	**0.110**	0.032 U	0.034 U	0.034 U	**0.088**	0.031 U	0.029 U	0.029 U	0.029 U	0.029 U	**0.071**	0.029 U	0.029 U	0.032 U	0.029 U	**0.216**	0.034 U	0.03 U	0.031 U

SWMU 4 and SWMU 5

			Sample ID	MO-10W-07	MO-11W-03B	MO-11W-04B	MO-12W-01	MO-12W-02	MO-12W-03	MO-13W-01	MO-13W-02	MO-14W-01	MO-14W-02	MO-14W-03	MO-15W-01	MO-15W-02	MO-15W-03	MO-16W-01	MO-16W-02	MO-16W-03
			Date	5/29/2002	6/3/2002	6/3/2002	5/15/2002	5/15/2002	5/15/2002	5/15/2002	5/15/2002	6/5/2002	6/5/2002	6/5/2002	6/6/2002	6/6/2002	6/7/2002	6/6/2002	6/6/2002	6/7/2002
			Sample Depth (ft bgs)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
VOCs	**Units**	**CASRN**	**Screening Level**																	
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	0.028 U	0.029 U	0.031 U	0.032 U	0.03 U	0.032 U	0.032 U	0.032 U	0.03 U	0.037 U	0.03 U	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	0.028 U	0.029 U	0.031 U	0.032 U	0.03 U	0.032 U	0.032 U	0.032 U	0.03 U	0.037 U	0.03 U	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	**1.120**	0.029 U	0.031 U	0.032 U	0.03 U	0.032 U	**0.359**	**1.770**	**0.051**	0.037 U	**0.060**	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	0.028 U	0.029 U	0.031 U	0.032 U	0.03 U	0.032 U	0.032 U	0.032 U	0.03 U	0.037 U	0.03 U	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	0.028 U	0.029 U	0.031 U	0.032 U	0.03 U	0.032 U	0.032 U	0.032 U	0.03 U	0.037 U	0.03 U	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	0.028 U	0.029 U	0.031 U	0.032 U	0.03 U	0.032 U	0.032 U	0.032 U	0.03 U	0.037 U	0.03 U	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.028 U	0.029 U	0.031 U	0.032 U	0.03 U	0.032 U	0.032 U	0.032 U	0.03 U	0.037 U	0.03 U	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	0.028 U	0.029 U	0.031 U	0.032 U	0.03 U	0.032 U	0.032 U	0.032 U	0.03 U	0.037 U	0.03 U	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.028 U	0.029 U	0.031 U	0.032 U	**0.089**	**0.110**	**0.100**	0.032 U	0.03 U	**0.069**	**0.041**	0.035 U	0.033 U	0.036 U	0.032 U	0.031 U	0.031 U

SWMU 26 and SWMU 31

			Sample ID	HA-1	HA-2	HA-3	HA-4	HA-5	P-1	P-1	P-2	P-2	P-3	P-3	P-4	P-4	P-5	P-6	P-7	P-7	P-9	P-9	P-10	P-10
			Date	10/5/1991	10/5/1991	10/5/1991	10/6/1991	10/6/1991	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997	4/29/1997
			Sample Depth (ft bgs)	2.0-4.0	4.0-4.3	0-2.0	0-0.75	0-2.0	8-12	16-17	10"-4'	4-6	10"-4'	4-5.5	10"-4'	4-6	6-7.5	5"-3.5'	4	4.5-5.5	0-4	4-7	4-8	8-11
VOCs	**Units**	**CASRN**	**Screening Level**																					
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	0.00084 U	0.0007 U	0.00084 U	0.0007 U	**0.072**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.079**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	0.0016 U	0.0013 U	0.0041	0.0013 U	0.0018 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.03**	**0.77**	0.005 U	0.005 U	0.005 U	0.005 U
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	0.0012 U	0.001 U	0.0012 U	0.001 U	**0.016**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	**0.036**	0.0003 U	0.00036 U	0.0003 U	**0.13**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.014**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	**0.55**	**0.014**	**0.018**	**0.0018**	**200**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.024**	**1.8**	**6**	0.005 U	**0.011**	0.005 U	0.005 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.00024 U	0.0002 U	0.00024 U	0.0002 U	**0.027**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	**3**	**0.029**	**0.01**	0.0012 U	**0.78**	**0.086**	**0.006**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.008**	**4**	**3.4**	**0.008**	**0.014**	**0.08**	**0.066**
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.0022 U	0.0018 U	0.0022 U	0.0018 U	**0.027**	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

TABLE 4-1

Soil Analytical Results Representative of Current Onsite Conditions

Modine Manufacturing Company, Camdenton, Missour.

				SWMU 26 and SWMU 31												
			Sample ID	MO-HB-055	MO-HB-085	MO-HB-120	MO-HB-120FD	BH-1	BH-1	BH-02	BH-2	BH-3	BH-3FD	BH-3	BH-5	BH-5
			Date	Oct 2006	Oct 2006	Oct 2006	Oct 2006	Dec 2007	Dec 2007	Dec 2007	Dec 2007	Dec 2007	Dec 2007	Dec 2007	Dec 2007	Dec 2007
			Sample Depth (ft bgs)	5	5	5	5	21	22	19.5	21.5	26	26	28	10	11.8
VOCs	**Units**	**CASRN**	**Screening Level**													
1,1-Dichloroethane	mg/kg	75-34-3	2.9E+02	**0.0019 J**	**0.0093**	**0.0096**	**0.0045 J**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1-Dichloroethene	mg/kg	75-35-4	4.3E+01	**0.0016 J**	**0.095**	**0.037**	**0.033**	**0.0097**	**0.008**	**0.022**	0.005 U	**0.0089**	**0.0200**	**0.013**	**0.0007 J**	**0.002 J**
cis-1,2-Dichloroethene	mg/kg	156-59-2	1.5E+01	**0.0031 J**	**0.064**	**0.031**	**0.0026 J**	**0.047**	**0.053**	**0.7 E**	**0.11**	**0.0068**	**0.0190**	**0.016**	**0.12**	**0.52E**
trans-1,2-Dichloroethene	mg/kg	156-60-5	1.8E+01	0.0057 U	0.0057 U	0.0057 U	U	0.005 U	0.005 U	**0.00071 J**	0.005 U	0.005 U	0.005 U	0.005 U	**0.0014 J**	0.005 U
Tetrachloroethene	mg/kg	127-18-4	1.7E+00	0.0057 U	**0.0067**	**0.019**	**0.014**	**0.003 J**	**0.0025 J**	**0.0021 J**	**0.00059 J**	**0.00075 J**	**0.0019 J**	**0.0014 J**	0.005 U	0.005 U
1,1,1-Trichloroethane	mg/kg	71-55-6	1.4E+03	0.0058 U	0.0058 U	**0.21**	**0.12**	**0.00048 J**	**0.00035 J**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1,2-Trichloroethane	mg/kg	79-00-5	1.9E+00	0.0058 U	0.0058 U	0.0064 U	U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Trichloroethene	mg/kg	79-01-6	9.2E-02	**0.039**	**0.69**	**0.15**	**0.24**	**3.7 E**	**3.8 E**	**3.6 E**	**0.44 E**	**1.9 E**	**3.2 E**	**2.8 E**	**0.015**	**0.006**
Vinyl Chloride	mg/kg	75-01-4	8.6E-01	0.0057 U	0.0057 U	0.0057 U	U	**0.005**	0.005 U	**0.0006 J**	0.005 U	0.005 U	0.005 U	0.005 U	**0.0021 J**	**0.0025 J**

Note:

NA - not available

Screening levels are USEPA Region 6 Human Health Medium-Specific Screening Levels for an industrial worker (the lower of the indoor worker and outdoor worker value), adjusted for a Hazard Quotient of 0.1 (December 2007)

Detected values are shown in bold

Detected values greater than their screening levels are bold and shaded

The screening values are for direct contact with soil.

E - Estimated result. Result concentration exceeded calibration range

J - Reported value is estimated

U - Chemical not detected above the method detection limit

Downgradient of SWMU 2 - Onsite Sewer Line samples with "B" included in the sample identification number indicate that the sample was collected from the base/floor of the excavation

Downgradient of SWMU 2 - Onsite Sewer Line samples with "W" included in the sample identification number indicate that the sample was collected from the wall of the excavation

TABLE 4-2

Comparison of VOCs Detected in Indoor Air Against Published Occupational Exposure Limits and Risk-Based Screening Levels

Modine Manufacturing Company, Camdenton, Missouri

Field ID	Description	Analytical Method	Chemical	Result (ppbv)	Screening Level (ppbv)	Occupational Exposure Limit (ppbv)
MD-AS-01	Office wing conference room	TO14	Methylene chloride	1.13	560	25,000
		TO14-SIM	Tetrachloroethene	0.2	47	25,000
		TO14	Trichloroethene	14.6	84	50,000
MD-AS-02	Office wing restroom sink area	TO14	cis-1,2-Dichloroethene	0.88 J	29	200,000
		TO14	Methylene chloride	0.64 J	560	25,000
		TO14-SIM	Tetrachloroethene	0.517	47	25,000
		TO14	Trichloroethene	61.5	84	50,000
MD-AS-03	NE plant corner	TO14-SIM	Tetrachloroethene	0.578	47	25,000
		TO14	Trichloroethene	46.7	84	50,000
MD-AS-04	Training room near chem. storage area	TO14-SIM	Tetrachloroethene	0.443	47	25,000
		TO14	Trichloroethene	56.5	84	50,000
		TO14-SIM	Vinyl chloride	0.009	81	1,000
MD-AS-05	Center of plant near welding bays	TO14-SIM	Tetrachloroethene	0.602	47	25,000
		TO14	Trichloroethene	42.2	84	50,000
		TO14-SIM	Vinyl chloride	0.015	81	1,000
MD-AS-06	S end of plant in historical degreaser location	TO14	cis-1,2-Dichloroethene	0.62 J	29	200,000
		TO14	Methylene chloride	0.81 J	560	25,000
		TO14-SIM	Tetrachloroethene	0.528	47	25,000
		TO14	Trichloroethene	34.6	84	50,000
MD-AS-07	OUTSIDE SAMPLE	TO14-SIM	Tetrachloroethene	0.053	47	25,000
		TO14-SIM	Trichloroethene	0.204	84	50,000
MD-AS-08	Duplicate of MD-AS-05	TO14-SIM	Tetrachloroethene	0.582	47	25,000
		TO14	Trichloroethene	42.7	84	50,000
		TO14-SIM	Vinyl chloride	0.015	81	1,000
MD-AS-B1	Blank	TO14-SIM	Trichloroethene	0.025	84	50,000

Notes:

J = The chemical was positively identified but the reported value is estimated.

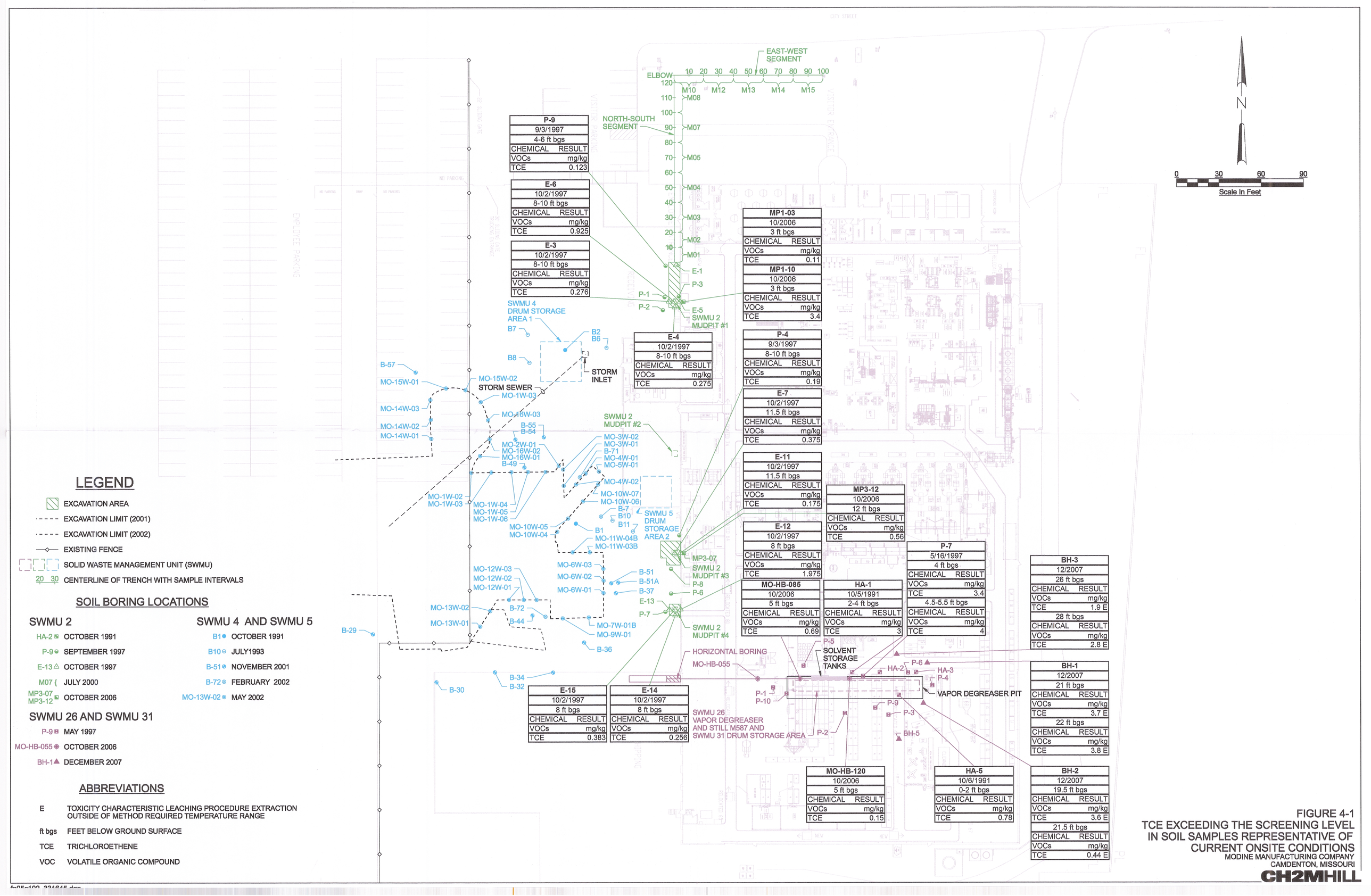
Screening Level - Based on MDNR recommended modifications of 10-4 Target Cancer Risk and 9 hours per day exposure time, rounded to two significant digits.

Occupational Exposure Limit value is the lowest of the OSHA PEL, ACGIH TLV and NIOSH REL.

OSHA PEL = Occupational Safety and Health Administration Permissible Exposure Limit

ACGIH TLV = American Council of Governmental Hygienists Threshold Exposure Limit

NIOSH REL = National Institute for Occupational Safety and Health Recommended Exposure Limits



LEGEND

- EXCAVATION AREA
- EXCAVATION LIMIT (2001)
- EXCAVATION LIMIT (2002)
- EXISTING FENCE
- SOLID WASTE MANAGEMENT UNIT (SWMU)
- 20 30 CENTERLINE OF TRENCH WITH SAMPLE INTERVALS

SOIL BORING LOCATIONS

SWMU 2

- HA-2 OCTOBER 1991
- P-9 SEPTEMBER 1997
- E-13 OCTOBER 1997
- M07 JULY 2000
- MP3-07 MP3-12 OCTOBER 2006

SWMU 4 AND SWMU 5

- B1 OCTOBER 1991
- B10 JULY1993
- B-51 NOVEMBER 2001
- B-72 FEBRUARY 2002
- MO-13W-02 MAY 2002

SWMU 26 AND SWMU 31

- P-9 MAY 1997
- MO-HB-055 OCTOBER 2006
- BH-1 DECEMBER 2007

ABBREVIATIONS

E	TOXICITY CHARACTERISTIC LEACHING PROCEDURE EXTRACTION OUTSIDE OF METHOD REQUIRED TEMPERATURE RANGE
ft bgs	FEET BELOW GROUND SURFACE
TCE	TRICHLOROETHENE
VOC	VOLATILE ORGANIC COMPOUND

FIGURE 4-1
TCE EXCEEDING THE SCREENING LEVEL IN SOIL SAMPLES REPRESENTATIVE OF CURRENT ONSITE CONDITIONS
MODINE MANUFACTURING COMPANY
CAMDENTON, MISSOURI

CH2MHILL

5. Fate and Transport

The approach to contaminant fate and transport is to describe the understanding of the migration pathways and potential critical receptor locations. This section discusses the fate and transport of TCE in the soil at the Modine facility. The following are potential migration pathways for TCE in the site soil:

- Leaching from soil to groundwater by infiltrating rainfall and stormwater runoff or continuous contact with groundwater
- Volatilization from soil to ambient or indoor air

This section addresses the potential for TCE to migrate along these pathways to cause potential receptor exposure.

5.1 Leaching

Precipitation that infiltrates into shallow soil can mobilize site-related contaminants in soil, transporting them along a vertically downward migration pathway deeper into the soil column. At the Modine facility, in the areas where TCE remains in soil at concentrations above the MSSL, the soil is protected from direct exposure to precipitation by an existing building and the concrete and asphalt paving surrounding it.

Contaminated soil could contribute to groundwater contamination through continuous contact with the groundwater table or frequent fluctuations in the groundwater table that bring it in contact with the contaminated soil. However, there is no evidence of accumulated groundwater within the unconsolidated zone at the Modine facility. Precipitation infiltrates the thin soil column, typically 5 to 30 feet thick; then, rather than accumulating at the bedrock surface, it rapidly migrates into the upper, unsaturated parts of the bedrock through the nearly vertical fractures. The shallowest water-bearing zone is the "perched" zone at roughly 130 feet beneath the lowest elevation of TCE-contaminated soil at the site. The presence of this perched zone is intermittent, making it unlikely that fluctuations in the "perched" groundwater surface would interact with the contaminated soil. Therefore, this pathway was not evaluated in the HHRA.

5.2 Volatilization

Volatilization of VOCs in soil can create both lateral and vertical migration pathways to indoor air. While volatilization through soil into the atmosphere of the building is a potential migration pathway, the concentrations of TCE in soil beneath the building, combined with the interior height of the building (roughly 18 feet), do not result in a significant threat to human health by VOCs in indoor air. Even so, the indoor air exposure pathway was evaluated in the HHRA.

6. Human Health Risk Assessment

This section provides the approach, assumptions, and conclusions of the HHRA conducted for site soil and indoor air.

6.1 Introduction

The HHRA was performed to evaluate the potential risks to human health posed by the chemicals detected in soil and indoor air at the Modine facility under current and future land use conditions. As presented in USEPA guidance documents, the HHRA is a four-step evaluation process that includes the following:

- Data evaluation
- Exposure assessment
- Toxicity assessment
- Risk characterization

These steps are discussed in detail below.

The following primary references were used in the HHRA:

- *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A)* (USEPA 1989)
- *RAGS, Volume I: Human Health Evaluation Manual (Part D, Standardized, Planning, Reporting, and Review of Superfund Risk Assessment) Final* (USEPA 2001a)
- *RAGS, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final* (USEPA 2004)

The supporting tables for the HHRA are presented in a format and numbering scheme consistent with RAGS Part D (USEPA 2001a) in Appendix A-1. Additional supporting tables for representative media concentrations (ProUCL output) are presented in Appendix A-2.

6.2 Data Evaluation

6.2.1 Summary of Data Used in the HHRA

The data set used in the HHRA consists of soil samples and indoor air samples.

6.2.1.1 Soil Data Set

The soil dataset consists of soil samples collected during the following field investigations conducted between 1991 and 2007:

- ESA (1991) and follow-up investigation (1993) conducted by Law Environmental, Inc.
- Soil Investigation conducted by Dames & Moore (1991, 1997a, 1997b,and 1997c)
- Various investigations conducted by CH2M HILL (2000, 2001, 2002a, 2007a, and 2007b)

Soil samples collected within the entire facility were divided into three data groups representing specific exposure areas for potential human receptors (Appendix A-1, Table 1). The soil samples collected from 0 to 3 feet bgs (including those currently under surface cover and the manufacturing building) were used to evaluate the future outdoor industrial worker scenario; the 0- to 3-ft-depth interval was identified as surface soil in accordance with MRBCA guidance. Soil samples collected from 0 to 10 feet bgs (including those currently under surface cover and the manufacturing building) were used to evaluate the future construction worker scenario. Soil samples collected between 0 and 28 ft bgs (including those currently under surface cover and the manufacturing building) were used to evaluate potential volatilization of constituents (within the entire soil column) to ambient air for the outdoor industrial worker and the construction worker.

The data set used for the HHRA excludes the soil samples collected from locations where remedial activities were conducted because the samples no longer represent current or future soil conditions. The final soil dataset used in the HHRA consists of 49 surface soil samples collected from 0 to 3 feet bgs, 126 subsurface soil samples collected from 0 to 10 feet bgs, and 137 total depth soil samples collected from 0 to 28 feet bgs for analysis of 10 selected chlorinated volatile organic compounds (cVOCs). For normal and field duplicate sample pairs, the normal sample result was used for the HHRA. Analytical results are presented in Table 4-1, and Figure 3-2 presents the soil sampling locations.

6.2.1.2 Air Data Set

The indoor air dataset used in the HHRA consists of Summa canister air samples from the Indoor Air Quality (IAQ) Assessment. The IAQ Assessment was conducted in accordance with the Corrective Action Work Plan Addendum 3 (CH2M HILL 2002b) submitted to the MDNR in December 2002. Verbal and subsequent email approval of the work plan with modifications was provided by MDNR in March 2003.

Air samples were collected from six locations within the onsite building and one outside of the building. One duplicate sample and one blank sample were also collected. Air samples were submitted for analysis of eight selected cVOCs. Analytical data are provided in Table 4-2.

6.2.2 Selection of COPCs

COPCs are chemicals that have the greatest potential to cause adverse human health effects when receptors come in contact with site media. Sections 3.2.1.2 (SWMU 2), 3.2.2.2 (SWMUs 4 and 5), and Section 3.2.4.2 (SWMUs 26 and 31) identify the VOCs remaining in site soil that are potentially related to historic site activities, as summarized below:

- SWMU 2—TCE, PCE, cis-1,2-DCE, and trans-1, 2-DCE
- SWMU 4 and 5—TCE, cis-1,2-DCE, and VC (it should be noted that concentrations are below historic screening levels)
- SWMUs 26 and 31—1,1-DCE, 1,1,1-TCA, and TCE

  Metals remaining in soil at SWMU 2 at concentrations above historic screening levels (lead and chromium) were not considered to be COPCs based on the rationale presented in Section 3.2.1.2.

6.2.2.1 Soil COPCs

COPCs were identified for soil by a two-step screening process that evaluated the frequency of detection (FOD) and a comparison to RBSVs.

Step 1: Frequency of Detection Evaluation

The FOD at which each chemical was detected was evaluated. Constituents detected at a frequency of 5 percent or less in each data group were eliminated from the HHRA. Constituents detected at a frequency greater than 5 percent were carried to Step 2 of the COPC screening process. Tables 2.1 through 2.3 of Appendix A-1 present the concentrations detected and the FOD. All chemicals with low FOD were also below the screening levels.

Step 2: Risk-Based Screening Value Comparison

For each chemical carried to Step 2, the maximum detected concentration was compared to its human health RBSV. In accordance with the recommendation by USEPA Region 7 (USEPA Region 7 2007), the USEPA Region 6 MSSLs (USEPA Region 6 2007) were used as the primary source of screening values. Industrial soil values were used since the current and future facility use is industrial. Indoor Worker and Outdoor Worker MSSLs for each detected chemical were compared and the lower of the two was selected as the soil RBSV for direct contact (i.e., ingestion, dermal contact, and inhalation of ambient air). MSSLs are based on a target ELCR of 10^{-6} for carcinogens and a HQ of 1 for non-carcinogens. MSSLs based on non-carcinogenic effects were divided by 10 (i.e., adjusted using a HQ of 0.1) to account for potential additive effects.

Those chemicals evaluated in Step 2 that exceeded their respective RBSVs were identified as COPCs for the specific exposure area. Results of the COPC selection process are provided in Tables 2.1 through 2.3 of Appendix A-1.

In summary, the following COPCs were identified;

- Soil (0 to 3 feet bgs)—TCE (**Table 2.1 of Appendix A-1**)
- Soil (0 to 10 feet bgs)—TCE (**Table 2.2 of Appendix A-1**)
- Soil (0 to 28 feet bgs)—TCE (**Table 2.3 of Appendix A-1**)

6.2.2.2 Indoor Air COPCs

All detected chemicals in indoor air were retained as COPCs and advanced into the Exposure Assessment.

In summary, the following COPCs were identified;

- Cis-1,2-DCE
- Methylene chloride
- PCE
- TCE
- VC

Results of the COPC selection process are provided in Table 2.4 of Appendix A-1.

6.3 Exposure Assessment

The exposure assessment consists of three main steps:

- Evaluation of potential exposure pathways and identification of potential receptors
- Estimation of exposure point concentrations (EPCs)
- Estimation of intakes

6.3.1 Evaluation of Exposure Pathways and Identification of Receptors

An exposure pathway evaluation was prepared that describes how a receptor could be exposed to COPCs at the site. A complete exposure pathway consists of four elements:

- A potential source or potential chemical release from a source
- An exposure point where contact can occur
- A receptor at the exposure point
- An exposure route by which contact can occur (for example, ingestion)

If all these conditions were not met, the pathway was concluded to be incomplete and was not considered in the HHRA. The potentially complete exposure pathways and receptors are identified in this section. Consistent with RAGS (USEPA 1989), current and future land use scenarios were considered.

The Modine facility occupies a 5-acre area bordered by residences to the northwest, north, and east, and by a wooded ravine to the south, southwest, and west. The Lake of the Ozarks is located 1.25 miles west of the facility.

The facility is zoned for industrial use and includes a 3-acre manufacturing building. Before 1997, the building was used to produce aluminum and copper heat transfer units, where chlorinated solvents were used to clean various parts and assembled units during a vapor degreasing process. Since then, the facility has produced radiators (larger heat transfer units) using aqueous-based alkali cleaners. No chlorinated vapor degreasing is used in the cleaning of the radiators. The future land use is expected to remain industrial/commercial.

The surface features of the facility are mostly paved surface with areas covered by grass on the south side of building and small scattered areas of gravel. Following the removal of soil contamination on the west side of the manufacturing building, most of the remaining soil contamination was underneath the manufacturing building. Because the surface features (building floor, concrete pavement) prevent potential receptors from coming directly into contact with the impacted soil, this exposure pathway is considered incomplete under current conditions. Since the current facility layout may change and future renovation/expansion activities may expose soil currently beneath pavement or the building, exposure to site soil was evaluated under the potential future scenario. Since affected soil remains beneath the building, volatilization of chemicals in subsurface soil to indoor air is a potentially complete migration pathway and was evaluated under the potential current and future exposure scenarios in the HHRA.

Shallow, non-potable groundwater occurs sporadically during the wetter months within the unconsolidated overburden atop the bedrock surface. The unconfined shallow site groundwater is as deep as 27 feet bgs. A deed restriction has been placed to prevent

uncontrolled invasive activities at the facility. Therefore, groundwater will not be contacted directly by construction workers or industrial workers.

Because site access is limited by a 6-foot tall fence and because the fence will remain intact in the future, trespassers are unlikely to gain access to the facility. However, trespassers may gain access to the site in the future if the fence is not maintained. Risk estimates for an industrial worker can be used to conservatively evaluate potential trespasser risks.

6.3.2 Conceptual Site Model

Based on the information provided in Section 6.2.1, a conceptual site model (Table 1 of Appendix A-1) was developed to depict the types of potential exposures to chemicals at or migrating from the site. The conceptual site model presents potentially affected onsite media, each group of potentially exposed receptors, and the potential exposure routes by which each receptor group may contact site-related chemicals. The conceptual site model was also used to identify the exposure pathways to be quantified in the HHRA based on the existing site characterization data, including assumptions about land use, and to verify exposure pathway screening assumptions.

6.3.3 Exposure Pathways to be Quantified

Various potential exposure pathways were quantified in the HHRA. The following potential exposures were quantified for the indicated receptors:

- **Outdoor Industrial Workers (Future)** — Ingestion and dermal contact exposures to COPCs in surface soil (0 to 3 feet) and inhalation exposures to VOCs in soil (0 to 28 ft) anywhere onsite — including under the building — were quantified for potential future outdoor industrial workers. The outdoor worker soil risk estimates can be used to conservatively estimate potential soil risks for indoor workers.

- **Construction Workers (Future)** — Ingestion and dermal contact of COPCs in subsurface soil (0 to 10 ft) and inhalation exposures to VOCs in soil (0 to 28 ft) anywhere onsite — including under the building — were quantified for potential future construction workers.

- **Indoor Industrial Workers (current/future)** — Inhalation exposures to COPCs in indoor air were quantified for current and future indoor industrial workers.

6.3.4 Quantification of Exposure

To evaluate the potentially complete exposure pathways, the magnitude, frequency, and duration of exposures were quantified. EPCs were identified and pathway-specific intakes were estimated. USEPA guidance (1989) recommends selecting intake variable values for a given pathway so that the combination of all intake variable values results in an estimate of the reasonable maximum exposure (RME) for that pathway. USEPA recommends using upper-bound parameter values (as opposed to average values) for exposure frequency and exposure duration.

6.3.5 Estimation of Exposure Point Concentrations

EPCs are the concentrations of COPCs in an environmental medium to which a receptor may be exposed at a specific location (the "exposure point"). EPCs can be based on analytical data obtained from onsite sampling or they may be estimated through modeling. For the outdoor industrial worker and construction worker, measured concentrations were used as the EPCs for oral and dermal exposures, while EPCs for inhalation of ambient air (containing volatiles generated from soil) were modeled. For the indoor industrial worker, air sampling data were used to identify air EPCs.

6.3.5.1 Calculation of Exposure Point Concentrations for Direct Contact With Soil

An upper confidence limit (UCL) concentration on the mean was calculated and used as the EPC for each soil data grouping. The UCL was calculated using ProUCL (version 4.0; USEPA 2007). USEPA has issued guidance for calculating the UCL of an unknown population mean for hazardous waste sites, and ProUCL software has been developed to compute an appropriate UCL of the unknown population mean. All UCL computation methods are contained in the ProUCL guidance documents. ProUCL tests for normality, lognormality, and gamma distribution of the data set, and computes a conservative and stable UCL of the unknown population mean. The computation of an appropriate UCL is based upon the assumption that the data set consists of observations only from a single population. The ProUCL-recommended value was used as the EPC. The soil EPCs are presented in Tables 3.1 and 3.2 of Appendix A-1, and the ProUCL output is provided in Appendix A-2.

6.3.5.2 Calculation of Exposure Point Concentrations for Ambient Air

The methodology presented in USEPA guidance (1996) was used to model the concentration of TCE in ambient air based on the soil EPC (i.e., UCL) in the 0- to 28-ft interval. A volatilization factor (VF) was used to calculate the concentration of volatilized TCE in ambient air. Calculation of the VF includes an inverse of the mean concentration at the center of the square source (Q/C) term that represents the dispersion of a contaminant in the atmosphere. The default Q/C values (the dispersion factor for wind erosion) of 58.18 $(g/m^2\text{-}s)/(kg/m^3)$ for the outdoor industrial worker and 14.31 $(g/m^2\text{-}s)/(kg/m^3)$ for the construction worker were obtained from USEPA technical guidance (USEPA 2002b) and used for the calculation of the VF. The other input values and specific equations used to calculate the VF are presented in Table 4 Supplements 1 and 2, respectively. Chemical and physical properties included in the Soil Screening Guidance (USEPA 1996) were used for the calculations.

Ambient air EPCs are presented in Table 3.3 of Appendix A-1, and the ProUCL output is provided in Appendix A-2.

6.3.5.3 Calculation of Exposure Point Concentrations for Indoor Air

UCL concentrations (e.g., 95 percent UCL) on the mean were calculated using the most recent version of ProUCL (Version 4.0; USEPA 2007). Based on the UCL value and maximum detected concentration of each chemical, the lesser of the two values was selected as an initial EPC. Initial EPCs were then adjusted to account for background concentrations attributable to outdoor air as well as error attributed to detections in the field blank:

- The outdoor air sample used for background comparison had detections for PCE and TCE. To determine final EPCs for PCE and TCE, the background values were subtracted from the initial EPC values.
- The only detected constituent in the field blank was TCE. The TCE blank value was subtracted from the background-adjusted TCE value to determine the final TCE EPC.

Indoor air EPCs are presented in Table 3.4 of Appendix A-1, and the ProUCL output is provided in Appendix A-2.

6.3.6 Estimation of Human Intake

Intake variables (exposure factors) were used to estimate COPC intakes. Exposure factors often are assumed values and their magnitude affects the estimates of potential exposure. The applicability of the selected values contributes to uncertainty in the resulting intake estimates. All the equations and exposure factors used to calculate intakes are presented in Tables 4.1 through 4.5 of Appendix A-1. The primary sources for the RME exposure factors are as follows:

- RAGS, Volume I: *Human Health Evaluation Manual – Supplemental Guidance: Standard Default Exposure Factors Interim Final* (USEPA 1991).
- RAGS, Volume I: *Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment* (USEPA 2004)
- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA 2002b)

6.4 Toxicity Assessment

The toxicity assessment describes the relationship between chemical exposure and the potential for occurrence of adverse health effects. Where possible, the assessment provides a numerical estimate of the potential for adverse health effects associated with chemical exposure. This subsection provides a brief description of the toxicity values used to characterize potential health risks from exposure to the COPCs.

COPCs are classified into two broad categories: carcinogens and non-carcinogens. This classification is employed because separate toxicity values are used, and potential health risks are calculated differently for carcinogenic and non-carcinogenic effects. Data from toxicity studies with laboratory animals or epidemiological studies of human populations are used to develop these toxicity values. In the risk characterization step, toxicity values were combined with exposure intakes to develop numerical estimates of carcinogenic health risks and estimates of non-cancer health risks.

The oral and inhalation toxicity values (cancer slope factors, oral reference doses [RfDs], inhalation unit risks, and inhalation reference concentrations) used in the risk assessment were obtained from the following hierarchy of sources and presented in Tables 5.1, 5.2, 6.1, and 6.2 of Appendix A-1:

- **Tier 1 Source – Integrated Risk Information System (IRIS) –** Database available online through the National Center for Environmental Assessment in Cincinnati and maintained by USEPA (2008).

- **Tier 2 Source—Provisional Peer-Reviewed Toxicity Values.** These values are developed by the USEPA Superfund Technical Support Center.
- **Tier 3 Sources**—Other Toxicity Values, including additional USEPA and non-USEPA sources of toxicity information, with priority given to those sources that are the most current, the basis for which is transparent and publicly available, and which have been peer-reviewed.
- **California Environmental Protection Agency (Cal/EPA).** This state agency maintains a toxicity criteria database; these values are currently accepted by various state environmental agencies, and are used in MDNR's MRBCA program (**Cal/EPA 2008**).
- **Agency for Toxic Substances and Disease Registry.** Database available online and maintained by the U.S. Department of Health and Human Services (**2008**).
- **Health Effects Assessment Summary Tables (HEAST).** As of 2002, HEAST toxicity values were replaced with Provisional Peer-Reviewed Toxicity Values, but for chemicals not yet reviewed, HEAST values may still be used.

Toxicity values provided by USEPA typically reflect administered-dose values; that is, they represent doses that will be protective for ingestion or inhalation exposures. The dermal route of exposure, however, is expressed as an absorbed intake. Therefore, the absorbed-dose intakes identified for dermal exposure must be compared to absorbed-dose toxicity values.

The absorbed-dose (dermal) toxicity values are derived by applying oral absorption factors to administered-dose (oral) toxicity values. The oral absorption factor of identified COPCs (i.e., cVOCs) are generally high (> 50 percent), and USEPA recommends assuming that the oral absorption factors is 100 percent based on review of literature (USEPA 2004). Therefore, the oral toxicity values were used as dermal toxicity values with no adjustment in the HHRA.

In accordance with USEPA guidance (1989), chronic toxicity values were used for exposure durations of 7 years or greater (i.e., for industrial workers), whereas subchronic toxicity values were used for exposure durations of less than 7 years (i.e., for construction workers). In cases where subchronic toxicity values were not available, chronic toxicity values were used as a conservative approach.

Currently, quantitative toxicity values are not available for TCE in USEPA's Tier 1 or Tier 2 sources of toxicity values. However, Cal/EPA (a Tier 3 source) has a set of toxicity values for TCE that are currently accepted by various state environmental agencies including MDNR. Therefore, the toxicity values in the Cal/EPA toxicity criteria database **(Cal/EPA, 2008)** were used for TCE in accordance with historic agreements with MDNR.

6.5 Risk Characterization

Risk characterization involves estimating the magnitude of potential adverse health effects from exposure to COPCs at a site. This estimation combines the estimated intakes (exposure levels) and toxicity factors to provide numerical estimates of potential carcinogenic health risks and semi-quantitative estimates of non-carcinogenic health risks. Risk characterization

also considers the nature and weight of evidence supporting these estimates, as well as the magnitude of uncertainty surrounding the estimates.

The risk estimates are intended to provide the basis for management decisions and do not predict actual health outcomes. The estimates are based on conservative (health-protective) assumptions, and thus, actual risks are likely to be less than these estimates, and may be zero.

6.5.1 Approach for Assessing Potential Non-carcinogenic Health Effects

Estimates of potential non-carcinogenic health risks were performed by calculating an HQ for each COPC by exposure route at the site. The HQ was calculated as the ratio of the estimated intake to the RfD as follows:

$$HQ = \frac{Intake}{RfD}$$

If the estimated daily intake for any COPC exceeds its RfD, the HQ will exceed 1. An HQ that exceeds 1 indicates there is a potential for adverse health effects associated with exposure to that COPC, but it does not indicate the actual level of risk.

A hazard index (HI) approach was used to evaluate non-carcinogenic health risks posed by one or more COPCs to which a receptor may be exposed by more than one exposure route. The HI approach assumes that simultaneous subthreshold exposures to several COPCs or exposure routes are additive. The HI is equal to the sum of the HQs, and is calculated as

$$HI = \frac{I_1}{RfD_1} + \frac{I_2}{RfD_2} + \ldots + \frac{I_i}{RfD_i}$$

where:

I = intake level [chronic daily intake (milligrams per kilogram per day [mg/kg-day])

RfD = chronic reference dose (mg/kg-day)

I_i = intake level (intake) for the *i*th constituent

RfD_i = reference dose for the *i*th constituent

A cumulative HI above 1.0 indicates the potential for adverse health effects. The cumulative HI is defined as the sum of the HQs for all media and all pathways of exposure for a particular receptor group.

According to USEPA (1989) guidance for non-carcinogens, it is appropriate to derive HI values based on target organ effects. However, since the estimated cumulative HIs were below the target level of 1.0, target organ-specific HIs are not discussed further.

6.5.2 Approach for Assessing Potential Cancer Risks

The ELCR for an individual COPC was calculated as the product of the intake and the cancer slope factor for the COPC as follows:

$$Risk = Intake \times CSF$$

USEPA's target range for carcinogenic risk associated with Comprehensive Environmental Response, Compensation, and Liability Act sites is 1×10^{-4} to 1×10^{-6}. That is, the risk associated with a site should not exceed this target range. For carcinogens, the MDNR uses a risk level of 1×10^{-5} as a threshold level for a single chemical from all complete exposure pathways and a risk level of 1×10^{-4} for sitewide (cumulative) risk from all chemicals and all complete exposure pathways (MDNR 2006b).

6.5.3 Risk Calculation Results

Potential ELCRs and HIs were calculated for potential receptors identified at the facility. Estimated intakes and associated risks for the RME scenarios are presented for specific exposure routes in Tables 7.1 through 7.3 of Appendix A-1 and a summary of the potential cumulative risks are presented in Tables 9.1 through 9.3 of Appendix A-1. Note that the risk estimates presented in this section are based on Cal/EPA's toxicity values for TCE.

- **Outdoor Industrial Workers (future)** — Ingestion and dermal contact exposures to surface soil and inhalation of ambient air were estimated for future industrial workers. The RME ELCR ($2x10^{-7}$) is below the MDNR's target cancer risk level of $1x10^{-5}$ for a single chemical and below USEPA's ELCR target range. The RME HI (0.0004) is below MDNR's and USEPA's target HI of 1.0 **(Table 9.1 of Appendix A-1).**
- **Construction Workers (future)** — Ingestion and dermal contact exposures to subsurface soil and inhalation of ambient air were estimated for future construction workers. The RME ELCR ($6x10^{-10}$) is below the MDNR's target cancer risk level of $1x10^{-5}$ for a single chemical and the USEPA's ELCR target range. The RME HI (0.00002) is below MDNR's and USEPA's target HI of 1.0 **(Table 9.2 of Appendix A-1).**
- **Indoor Industrial Workers (current/future)** — Inhalation of indoor air was assessed for current/future industrial workers. Although the RME ELCR ($7x10^{-5}$) does not meet the MDNR's target cancer risk level of $1x10^{-5}$ for a single chemical, the RME ELCR does meet USEPA's target range and the cumulative ELCR target range for MDNR. The maximum target organ-specific HI (0.2) is below MDNR's and USEPA's target HI of 1.0 (**Table 9.3 of Appendix A-1**).

6.6 Uncertainty Assessment

All HHRAs involve the use of assumptions, professional judgments, and imperfect data to varying degrees, which result in uncertainty in the final estimates of risk. This section describes the likelihood that the approaches incorporated into the HHRA may result in an overestimate or underestimate of actual risks associated with exposure to site chemical concentrations. The major uncertainties associated with the HHRA conducted for the Modine facility are the risks calculated for TCE as discussed in the following paragraphs.

The CAL/EPA toxicity values are based exclusively on mouse inhalation studies. The "uptake and distribution factors" were reported to be in "good agreement" with human volunteers. The good agreement between the mouse inhalation studies and the estimated

correlation to humans increases confidence in choosing the Cal/EPA inhalation values for assessment of the inhalation pathway.

USEPA released an external review draft document entitled, "Trichloroethylene Health Risk Assessment: Synthesis and Characterization" (USEPA 2001b), proposing quantitative toxicity values for non-carcinogenic and carcinogenic endpoints. Considerable uncertainty exists with these draft toxicity values. Mechanisms of TCE-induce adverse health effects and carcinogenesis are very complex, as much of TCE-induced toxicity may be attributable to metabolites such as trichloroacetic acid (TCA) and dichloroacetic acid (DCA). Metabolite formation is different at high and low doses of TCE and metabolism can be altered by metabolites that are already present. In considering TCA and DCA as dose metrics, different exposures routes yield different proportion of metabolite formation, which in turn yield different route extrapolations. TCE is primarily metabolized in the liver, and it is not known whether these dose metrics are appropriate indicators of liver toxicity. Several metabolites of TCE, including TCA and DCA, are environmental toxins present in water, and these along with other liver toxins such as alcohol or acetaminophen can contribute to humans having a higher dose-response curve than test animals. The draft RfD includes a data-derived factor of 50 for human variation and default factors of 100 overall for uncertainty in extrapolating from animals to humans, from subchronic studies to lifetime exposure, from effect levels to NOAELs, and from single-chemical toxicity tests to complex exposures involving multiple chemicals.

USEPA's draft 2001 toxicity values were used to calculate a second set of risk and HI estimates for TCE (Table 9-3 Supplement of Appendix A-1):

- Indoor industrial worker—ELCR = $4x10^{-3}$, which is above both the MDNR target risk level and the USEPA acceptable risk range; HI = 2, which exceeds the MDNR and USEPA target HI (1.0).
- Outdoor industrial worker—ELCR = $9x10^{-6}$, which is below both the MDNR target risk level and the USEPA acceptable risk range; HI = 0.006, which meets both the MDNR and USEPA target HI (1.0).

It is important to note that although risk estimates based on the USEPA 2001 draft TCE toxicity values indicate a potential for unacceptable risk for the indoor industrial worker, estimation of risk using the Cal/EPA toxicity values is expected to be more representative of the inhalation pathway.

The ambient air concentrations of TCE modeled from the entire soil column is another source of uncertainty in the HHRA. Use of the entire soil interval from the surface to the depth of groundwater (0 to 28 feet) is expected to overestimate potential ambient air concentrations.

6.7 Summary and Conclusions

Potential risks to human health posed by the chemicals detected in soil and indoor air at the Modine facility were evaluated based on soil and air samples collected during various sampling events conducted from 1991 through 2007.

Three potential exposure scenarios (potential receptors and exposure areas) were identified at the facility based on the current and foreseeable future land uses. Future industrial outdoor workers and future construction workers were conservatively evaluated for direct contact exposures (i.e., ingestion/dermal contact) using surface soil samples (0- to 3-foot interval) for industrial workers and construction zone soil samples (0- to 10-foot interval) for construction workers; total soil samples (0- to 28-foot interval) collected from the entire facility were used to evaluate potential ambient air exposures from volatilization. All soil groupings used included soil currently situated under surface cover and the manufacturing building. The current/future industrial workers were evaluated for inhalation of indoor air using air samples collected within the current manufacturing building.

The maximum detected concentrations in each exposure area were compared to their respective RBSVs to identify COPCs. Based on the results of the comparisons, TCE was identified as a COPC for future outdoor industrial workers and future construction worker scenarios (for surface soil, construction zone soil, and total soil), whereas five chemicals (cis-1,2-DCE, methylene chloride, PCE, TCE, and VC) were identified as indoor air COPCs for the current/future indoor industrial worker scenario inside the manufacturing building.

Chemical intakes of the identified COPCs were estimated using USEPA's default RME assumptions and EPCs (i.e., 95 percent UCL on the mean or maximum detected values) for the potential receptors. Subsequently, cumulative site risks were estimated by combining the calculated intake rates and USEPA's standard toxicity values. Estimated ELCRs and HIs for the potential outdoor industrial worker and construction worker receptors evaluated in the HHRA were below the MDNR's target ELCR of $1x10^{-5}$ for a single chemical and HI of 1.0 based on Cal/EPA's toxicity values for TCE. Estimated ELCRs and HIs for the current/future indoor industrial worker receptor evaluated in the HHRA met USEPA's target cancer risk level of $1x10^{-4}$ and were below a HI of 1.0 for cis-1,2-DCE, methylene chloride, PCE, TCE, and VC.

7. Ecological Risk Assessment

An ecological risk assessment (ERA) was conducted consistent with the draft final MRBCA technical guidance (MDNR 2006b). Under the MRBCA guidance, potential ecological risks are addressed using a phased approach within an overall MRBCA tiered risk assessment process. Details of the tiered risk assessment approach, which include the approach for human health risk, are provided in the MRBCA guidance.

The general process for identifying the need to conduct an ERA is depicted in Figure 5-1 of the MRBCA guidance. The need to conduct an ERA is determined following site discovery by comparing the maximum concentrations of COPCs in groundwater to MRBCA Table 5-1 (compiled from Missouri's Water Quality Standards, 10 CSR 207.031). As described in Section 3.1, groundwater was not investigated as a potential source of site-related contamination at this site, indicating that an ecological evaluation may not be warranted. To support this determination, a Level 1 ERA was performed to identify whether ecological receptors or habitat exist at, adjacent to, or near the site. The evaluation, beginning with MRBCA ERA Level 1 Checklist A (MRBCA Appendix F), consists of seven questions. The checklist is a qualitative evaluation completed by an experienced environmental professional. If the answer to all questions on the checklist is negative, no further ecological evaluation is necessary. A positive answer to any question in Checklist A implies that a receptor or a habitat exists on or near the site, and so further evaluation is required. A second checklist of seven questions, ERA Level 1 Checklist B, is then completed. The second checklist determines if pathways are complete for receptors identified in Checklist A. If the answer to the questions is negative, the conclusion is that, even though a receptor exists on or near the site, a complete pathway to the receptor does not exist and the site poses no ecological concerns. If the answer to even one question is positive, a Level 2 ERA is required to determine whether contamination at the site poses an unacceptable risk to ecological receptors.

The results of ERA Checklists A and B are presented in Tables 7-1 and 7-2. Since the site is within 0.5 mile of Hulett Lagoon and the surrounding area is heavily forested, there are ecological receptors in the site vicinity. However, site-related contaminants have not migrated offsite and are currently in the shallow subsurface below asphalt pavement or gravel or in the deeper subsurface. Chemicals are not present in exposed surface soil or accessible in shallow subsurface soil by burrows or root uptake and there is no surface water onsite. Although receptors are present in the site vicinity (Checklist A), complete pathways to these receptors do not exist (Checklist B), and no further investigation (a Level 2 ERA) is necessary. Karstic features do exist in the vicinity of the site, however, no hydrogeologic connection has been demonstrated between the site and the karst features. Therefore, the answer to question 7a in Table 7-2 is "no."

TABLE 7-1

Results of MRBCA Appendix F Checklist A

Modine Manufacturing Company, Camdenton, Missouri

Checklist Question	Answers	
Is the boundary of the contaminated area less than ½ mile to a surface waterbody (stream, river, pond, lake, etc.)?	Y	Hullett Lagoon is located within 0.5 mile of the site. Please see Figure 1-1 - Site Location Map.
Are wetlands (as defined by the 1987 Corps of Engineers' Delineation Manual) on or adjacent to the site?	Y	Hullett Lagoon is located within 0.5 mile of the site. This can be seen on Figure 3-3 indicating the wetland designation near MW-8.
Are contaminated soils uncovered or otherwise accessible to ecological receptors and the elements?	N	Site-related constituents are present only in shallow subsurface soil below asphalt pavement or gravel or in the deeper subsurface. Ecological receptors are not in contact with these media.
Are there karstic features (see Ecological Risk Assessment Figure #2 for definition) on or within ½ mile of the boundary of the contaminated area?	P	Karst features exist throughout this area of Missouri.
Are there federal or state rare, threatened, or endangered species on or within ½ mile of the contaminated area?	P	Based on current information, no federal or state rare, threatened, or endangered species have been observed within 0.5 mile of site, however, there is the potential that these species exist within this region.
Are there one or more environmentally sensitive areas (see Ecological Risk Assessment Figure #1 for definition) at or within ½ mile of the contaminated area?	Y	Hullett Lagoon is located within 0.5 mile of the site and is considered an environmentally sensitive area
Are commercially or recreationally important species (fauna or flora) on or within ½ mile of the contaminated area?	P	Although not confirmed, there is the potential for these species to exist within the adjacent forested area.

Notes:

Y - Yes

N - No

P - Potential

TABLE 7-2
Results of MRBCA Appendix F Checklist B
Modine Manufacturing Company, Camdenton, Missouri

Checklist Questions	Answer	
Question 1: Could contaminants associated with the site reach ecological receptors via groundwater? 1.a.) Can contaminants associated with the site leach, dissolve, or otherwise migrate to groundwater? 1.b.) Are contaminants associated with the site mobile in groundwater? 1.c.) Does groundwater from the site discharge to ecological receptor habitat?	N	Please see Section 5.1
Question 2: Could contaminants from the site reach ecological receptors via migration of NAPL? 2.a.) Is Non Aqueous Phase Liquid (NAPL) present at the site? 2.b.) Is NAPL migrating? 2.c.) Could NAPL discharge occur where ecological receptors are found?	N	NAPL is not present at the site
Question 3: Could contaminants reach ecological receptors via erosional transport of contaminated soils or via precipitation runoff? 3.a.) Are contaminants present in surface soils? 3.b.) Can contaminants be leached from or be transported by erosion of surface soils?	N	Site-related constituents are present only in shallow subsurface soil below asphalt pavement or gravel or in the deeper subsurface. Erosion and precipitation run-off of site-related constituents is not occurring.
Question 4: Could contaminants reach ecological receptors via direct contact? 4.a.) Are contaminants present in surface soil or on the surface of the ground? 4.b.) Are potential ecological receptors on the site?	N	Ecological receptors could occur on-site but site-related constituents are present only in shallow subsurface soil below asphalt pavement or gravel or in the deeper subsurface. Ecological receptors are not in contact with these media.
Question 5: Could contaminants reach ecological receptors via inhalation of volatilized contaminants or contaminants adhered to dust in ambient air or in subsurface burrows? 5.a.) Are contaminants present on the site volatile? 5.b.) Could contaminants on the site be transported in air as dust or particulate matter?	N	Please see Sections 6.6.2. Exposure through inhalation is not expected. In March 2003, an indoor air quality assessment was performed. All concentrations of VOCs were detected well below the lowest available occupational exposure level.
Question 6: Could contaminants reach ecological receptors via direct ingestion of soil, plants, animals or 6.a.) Are contaminants present in surface and shallow subsurface soils or on the surface of the ground? 6.b.) Are contaminants found in soil on the site taken up by plants growing on the site? 6.c.) Do potential ecological receptors on or near the site feed on plants (e.g., grasses, shrubs, forbs, trees, etc.) found on the site? 6.d.) Do contaminants found on the site bioaccumulate?	N	Site-related constituents are present only in shallow subsurface soil below asphalt pavement or gravel or in the deeper subsurface. Ecological receptors are not exposed to these media. Site-related constituents are not migrating to exposure media for ecological receptors (i.e., sediment, surface water, and surface soil).
Question 7: Could contaminants reach ecological receptors via transport through a karst system? 7.a.) Are there karstic features (see Ecological Risk Assessment Figure #2 for definition) on or within ½ mile of the contaminated area? 7.b.) Is there a hydrogeological connection between the site and karstic features such as seeps, springs, streams or other surface water bodies?	N	Karstic features exist in the vicinity of the site but no hydrogeologic connection has been demonstrated between the site and the karst features, *The Stratigraphic Succession in Missour, Missouri Geologisl Survey and Water Resources, 1961.*

Notes:
N - No

8. Conclusions and Recommendations

This RFI Report summarizes existing data available for the site, summarizes previous remedial activities, assesses the nature and extent of contamination remaining in site soils, reviews fate and transport of the remaining contaminants, and quantifies the potential risk posed by any site-related contamination to human health and the environment. This RFI Report is being submitted under the Action Order on Consent negotiated by Modine and the MDNR in July 1999.

A visual site inspection /preliminary assessment conducted at the Modine facility in 1992 recommended further investigation at a few SWMUs. None of the SWMUs are currently active. Several investigations were conducted between 1992 and 2007 at the Modine facility to assess the potential for releases from these SWMUs. Based on the results from some of these investigations, remedial activities were conducted to remove contaminated soil during this time period. The data generated from the investigations and remedial activities were evaluated to determine what chemicals remain in site soils that could still pose a risk to human health and the environment.

To assess the nature of contamination, soil concentration data representative of current onsite conditions were compared against screening levels based on USEPA Region 6 Human Health MSSLs as part of this RFI. The only chemical identified in excess of the screening levels was TCE. The evaluation of the TCE data concluded that the extent of TCE contamination has been adequately defined to the concentration previously agreed upon (4 mg/kg) by Modine and MDNR as a result of previous investigations.

Migration pathways were assessed as part of the RFI to determine the potential fate and transport of TCE contamination in soil. The leaching to groundwater pathway was evaluated and determined to be incomplete since the TCE remaining in soil at concentrations exceeding the MSSLs is protected from direct exposure to precipitation by a building and the concrete and asphalt surrounding the building.

The HHRA found risk estimates to be within acceptable USEPA and MDNR cumulative risk levels for future industrial workers and future construction workers from direct contact with soil and for current/future industrial workers from inhalation of indoor air. TCE in indoor air exceeds the MDNR target risk level for an individual chemical. The ecological risk assessment found that although receptors are present nearby, complete pathways to these receptors do not exist.

An environmental covenant, which meets the requirements of the Missouri Environmental Covenants Act, RSMo, Section 260.1000 through 260.1039, has been prepared for the Modine Manufacturing Company facility in Camdenton, Missouri. Residential land use is defined as property whose use is unrestricted and children under 18 years of age are on the property more than 250 days per year. The environmental covenant provides for activity and use limitations restricting the property to non-residential use, prohibiting drilling or the use of groundwater for domestic purposes, and limitations restricting the disturbance of soil under the existing building. These limitations exclude the use or development of the property or

portions of the property for any day care, preschool, playground, athletic field, dormitory or nursing home purposes, or for any residential purposes. These limitations also require the owner or operator to request permission from MDNR at least 60 days before soil disturbance activities beneath the building begin. MDNR may deny the request for soil disturbance or require protective or remedial actions prior to soil disturbance activities based on the findings presented in this report. In addition, the owner or operator of the property is required to allow access to the property for the purpose of environmental groundwater monitoring at existing onsite wells.

Based on results of the RFI, there is no need to move forward with a Corrective Measures Study. The path forward includes MDNR taking the lead to inform the public. Given that no significant concerns are raised by the public that MDNR considers relevant for consideration, the site will be closed with no further action.

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Appendix A-1
Human Health Risk Assessment Tables

TABLE 1

SELECTION OF POTENTIALLY COMPLETE EXPOSURE PATHWAYS

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Soil (the Entire Site)	Surface Soil (0-3 ft)	Surface Soil (0-3 ft)	Industrial Worker	Adult	Dermal	Quant	Industrial workers may contact surface soil.
						Ingestion	Quant	Industrial workers may contact surface soil.
				Trespasser	Adolescent	Dermal	Qual	Trespassers may gain access to the site if the fence is not maintained; risk estimates for an industrial worker can be used to evaluate potential trespasser risks.
						Ingestion	Qual	Trespassers may gain access to the site if the fence is not maintained; risk estimates for an industrial worker can be used to evaluate potential trespasser risks.
		Subsurface Soil (0-10 ft)	Subsurface Soil (0-10 ft)	Construction Worker	Adult	Dermal	Quant	Construction workers may contact subsurface soil.
						Ingestion	Quant	Construction workers may contact subsurface soil.
		Ambient Air From Soil (0-28 ft)	Ambient Air	Construction Worker Industrial Worker	Adult	Inhalation	Quant	Construction workers may inhale vapors and dust.
				Trespasser	Adolescent	Inhalation	Qual	Trespassers may gain access to the site if the fence is not maintained; risk estimates for an industrial worker can be used to evaluate potential trespasser risks.
Current/Future	Indoor Air	Indoor Air	Manufacturing Building	Industrial Worker	Adult	Inhalation	Quant	Indoor industrial workers may inhale vapors present in indoor air.

Type of Analysis:

Qual - Qualitative analysis

Quant - Quantitative analysis

Table 2.1

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Exposure Medium: Surface Soil (0-3 ft bgs)

Exposure Point	CAS Number	Chemical	Minimum Concentration Qualifier		Maximum Concentration Qualifier		Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value	Screening Toxicity Value (2)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (2)
Surface Soil (0-3 ft)	71-55-6	1,1,1-Trichloroethane	0.0012		200		mg/kg	HA-5	7 / 49	0.0018 - 0.0074	200	NA	1.4E+03	sat	NA	NA	No	BSL
	79-00-5	1,1,2-Trichloroethane	0.027		0.027		mg/kg	HA-5	1 / 49	0.0002 - 0.0074	0.027	NA	1.9E+00	C	NA	NA	No	BSL, FOD
	75-34-3	1,1-Dichloroethane	0.0062		0.072		mg/kg	HA-5	2 / 49	0.00043 - 0.0074	0.072	NA	2.9E+02	N	NA	NA	No	BSL, FOD
	75-35-4	1,1-Dichloroethylene	0.0041		0.0041		mg/kg	HA-3	1 / 49	0.001 - 0.0074	0.0041	NA	4.3E+01	N	NA	NA	No	BSL, FOD
	156-59-2	1,2-Dichloroethylene (cis)	0.004		1.01		mg/kg	MO-SB37	7 / 7	-	1.01	NA	1.5E+01	N	NA	NA	No	BSL
	156-60-5	1,2-Dichloroethylene (trans)	0.0075		0.016		mg/kg	HA-5	2 / 18	0.001 - 0.006	0.016	NA	1.8E+01	N	NA	NA	No	BSL
	540-59-0	1,2-Dichloroethylene, Total	0.0083		0.16		mg/kg	M01W	5 / 31	0.005 - 0.0071	0.16	NA	1.5E+01	N	NA	NA	No	BSL
	127-18-4	Tetrachloroethylene (PCE)	0.0058		0.13		mg/kg	HA-5	4 / 49	0.0003 - 0.0074	0.13	NA	1.7E+00	C	NA	NA	No	BSL
	79-01-6	Trichloroethylene (TCE)	0.008		3		mg/kg	HA-1	11 / 49	0.001 - 0.0074	3	NA	9.2E-02	C	NA	NA	Yes	ASL
	75-01-4	Vinyl chloride	0.0031	J	0.12		mg/kg	MO-SB37	5 / 49	0.0018 - 0.01	0.12	NA	8.6E-01	C	NA	NA	No	BSL

(1) Maximum concentration is used for screening comparison.

(2) EPA Region 6 Medium-Specific Screening Levels (MSSL) for Industrial Soil, 2008.
The lower of Industrial Indoor Worker and Industrial - Outdoor Worker MSSLs was used.
MSSLs based on non-carcinogenic health effects are adjusted using HQ=0.1
1,2-Dichloroethylene (cis) was used as a surrogate for 1,2-Dichloroethylene, Total

(3) Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Below Screening Level (BSL)
Frequency of Detection (FOD)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

J - The associated value is an estimated quantity.

C = Carcinogenic
N = Noncarcinogenic
sat = Soil saturation
NA = Not available

Table 2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Exposure Medium: Subsurface Soil (0-10 ft bgs)

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value	Screening Toxicity Value (2)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (2)
Subsurface Soil (0-10 ft)	71-55-6	1,1,1-Trichloroethane	0.0012		200		mg/kg	HA-5	12 / 126	0.0018 - 0.037	200	NA	1.4E+03	sat	NA	NA	No	BSL
	79-00-5	1,1,2-Trichloroethane	0.0026	J	0.027		mg/kg	HA-5	2 / 126	0.0002 - 0.037	0.027	NA	1.9E+00	C	NA	NA	No	BSL, FOD
	75-34-3	1,1-Dichloroethane	0.0019	J	0.079		mg/kg	P-7	7 / 126	0.00043 - 0.037	0.079	NA	2.9E+02	N	NA	NA	No	BSL
	75-35-4	1,1-Dichloroethylene	0.0007	J	0.77		mg/kg	P-7	11 / 126	0.001 - 0.037	0.77	NA	4.3E+01	N	NA	NA	No	BSL
	156-59-2	1,2-Dichloroethylene (cis)	0.0031	J	3.42		mg/kg	MO-10W-06	47 / 73	0.002 - 0.037	3.42	NA	1.5E+01	N	NA	NA	No	BSL
	156-60-5	1,2-Dichloroethylene (trans)	0.0014	J	0.016		mg/kg	HA-5	5 / 85	0.001 - 0.037	0.016	NA	1.8E+01	N	NA	NA	No	BSL
	540-59-0	1,2-Dichloroethylene, Total	0.0083		0.16		mg/kg	M01W	9 / 41	0.005 - 0.0071	0.16	NA	1.5E+01	N	NA	NA	No	BSL
	127-18-4	Tetrachloroethylene (PCE)	0.0058		0.451		mg/kg	E-14	9 / 126	0.0003 - 0.037	0.451	NA	1.7E+00	C	NA	NA	No	BSL
	79-01-6	Trichloroethylene (TCE)	0.0021	J	4		mg/kg	P-7	38 / 126	0.001 - 0.068	4	NA	9.2E-02	C	NA	NA	Yes	ASL
	75-01-4	Vinyl chloride	0.0025	J	0.216		mg/kg	MO-9W-01	20 / 126	0.0018 - 0.036	0.216	NA	8.6E-01	C	NA	NA	No	BSL

(1) Maximum concentration is used for screening comparison.

(2) EPA Region 6 Medium-Specific Screening Levels (MSSL) for Industrial Soil, 2008.
The lower of Industrial Indoor Worker and Industrial - Outdoor Worker MSSLs was used.
MSSLs based on non-carcinogenic health effects are adjusted using HQ=0.1
1,2-Dichloroethylene (cis) was used as a surrogate for 1,2-Dichloroethylene, Total

(3) Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Below Screening Level (BSL)
Frequency of Detection (FOD)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

J - The associated value is an estimated quantity.

C = Carcinogenic
N = Noncarcinogenic
sat = Soil saturation
NA = Not available

Table 2.3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (The Entire Site)
Exposure Medium: Ambient Air From All Soil (0-28 ft bgs)

Exposure Point	CAS Number	Chemical	Minimum Concentration Qualifier		Maximum Concentration Qualifier		Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value	Screening Toxicity Value (2)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (2)
Manufacturing Building	71-55-6	1,1,1-Trichloroethane	0.00035	J	200		mg/kg	HA-5	14 / 137	0.0018 - 0.037	200	NA	1.4E+03	sat	NA	NA	No	BSL
	79-00-5	1,1,2-Trichloroethane	0.0026	J	0.027		mg/kg	HA-5	2 / 137	0.0002 - 0.037	0.027	NA	1.9E+00	C	NA	NA	No	BSL, FOD
	75-34-3	1,1-Dichloroethane	0.0019	J	0.079		mg/kg	P-7	7 / 137	0.00043 - 0.037	0.079	NA	2.9E+02	N	NA	NA	No	BSL
	75-35-4	1,1-Dichloroethylene	0.00063	J	0.77		mg/kg	P-7	18 / 137	0.001 - 0.037	0.77	NA	4.3E+01	N	NA	NA	No	BSL
	156-59-2	1,2-Dichloroethylene (cis)	0.0031	J	3.42		mg/kg	MO-10W-06	57 / 83	0.002 - 0.037	3.42	NA	1.5E+01	N	NA	NA	No	BSL
	156-60-5	1,2-Dichloroethylene (trans)	0.00071	J	0.016		mg/kg	HA-5	6 / 95	0.001 - 0.037	0.016	NA	1.8E+01	N	NA	NA	No	BSL
	540-59-0	1,2-Dichloroethylene, Total	0.0083		0.16		mg/kg	M01W	9 / 42	0.005 - 0.0071	0.16	NA	1.5E+01	N	NA	NA	No	BSL
	127-18-4	Tetrachloroethylene (PCE)	0.00059	J	0.451		mg/kg	E-14	15 / 137	0.0003 - 0.037	0.451	NA	1.7E+00	C	NA	NA	No	BSL
	79-01-6	Trichloroethylene (TCE)	0.0021	J	4		mg/kg	P-7	49 / 137	0.001 - 0.068	4	NA	9.2E-02	C	NA	NA	Yes	ASL
	75-01-4	Vinyl chloride	0.0006	J	0.216		mg/kg	MO-9W-01	23 / 137	0.0018 - 0.036	0.216	NA	8.6E-01	C	NA	NA	No	BSL

(1) Maximum concentration is used for screening comparison.

(2) EPA Region 6 Medium-Specific Screening Levels (MSSL) for Industrial Soil, 2008.
The lower of Industrial Indoor Worker and Industrial - Outdoor Worker MSSLs was used.
MSSLs based on non-carcinogenic health effects are adjusted using HQ=0.1
1,2-Dichloroethylene (cis) was used as a surrogate for 1,2-Dichloroethylene, Total

(3) Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Below Screening Level (BSL)
Frequency of Detection (FOD)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

J - The associated value is an estimated quantity.

C = Carcinogenic
N = Noncarcinogenic
sat = Soil saturation
NA = Not available

Table 2.4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Current/Future
Medium: Indoor Air
Exposure Medium: Indoor Air

Exposure Point	CAS Number	Chemical	Minimum Concentration	Qualifier	Maximum Concentration	Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Initial Exposure Point Concentration (1)	Outdoor Background Value	Blank Detection Value	Final Exposure Point Concentration	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (2)
Manufacturing Building	75-34-3	1,1-Dichloroethane	1.00	U	4.50	U	PPBV	MD-AS-03	0 / 7	0.5 - 2.25	NA	NA	NA	NA	NA	NA	No	ND
	75-35-4	1,1-Dichloroethylene	1.00	U	4.50	U	PPBV	MD-AS-03	0 / 7	0.5 - 2.25	NA	NA	NA	NA	NA	NA	No	ND
	156-59-2	1,2-Dichloroethylene (cis)	0.62		0.88		PPBV	MD-AS-02	2 / 7	0.5 - 2.25	0.88	NA	NA	0.88	NA	NA	Yes	DET
	75-09-2	Methylene chloride	0.64		1.13		PPBV	MD-AS-01	3 / 7	0.5 - 2.25	1.13	NA	NA	1.13	NA	NA	Yes	DET
	127-18-4	Tetrachloroethylene (PCE)	0.2		0.582		PPBV	MD-AS-05	6 / 7	0.004 - 0.016	0.582	0.053	NA	0.55	NA	NA	Yes	DET
	71-55-6	1,1,1-Trichloroethane	1.00	U	4.50	U	PPBV	MD-AS-03	0 / 7	0.5 - 2.25	NA	NA	NA	NA	NA	NA	No	ND
	79-01-6	Trichloroethylene (TCE)	14.6		61.5		PPBV	MD-AS-02	7 / 7	0.004 - 0.016	61.5	0.204	0.025	61.27	NA	NA	Yes	DET
	75-01-4	Vinyl chloride	0.009		0.015		PPBV	MD-AS-02	3 / 7	0.004 - 0.016	0.032	NA	NA	0.015	NA	NA	Yes	DET

(1) Maximum concentration is used for screening comparison.

(2) Rationale Codes

Selection Reason: Detected Constituent (DET)

Deletion Reason: Undetected Constituent (ND)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

U - The chemical was undetected in the sampling media

Table 3.1.RME

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Exposure Medium: Surface Soil (0-3 ft)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (N/T/G)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Surface Soil (0-3 ft)	Trichloroethylene (TCE)	mg/kg	3.8E-01	3.7E-01 (T)	3.0E+00	3.7E-01	mg/kg	95% KM (Chebyshev) UCL	(1)

Full statistics for data included in Appendix A-2.

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in User's guide (EPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).

The arithmetic mean presented in this table is the mean of the detected values.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) Shapiro-Wilk W Test indicates data are normally distributed.

(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.

(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

(5) The maximum detected concentration was used as the UCL because the value recommended by ProUCL was higher than the Max.

(6) The maximum detected concentration was used as the UCL because the number of detected concentration was less than 2.

G = Gamma distribution.

N = Normal distribution.

T = Log-normal distribution.

Table 3.2.RME

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Exposure Medium: Subsurface Soil (0-10 ft)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (N/T/G)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Subsurface Soil (0-10 ft)	Trichloroethylene (TCE)	mg/kg	5.5E-01	4.2E-01 (T)	4.0E+00	4.2E-01	mg/kg	95% KM (Chebyshev) UCL	(1)

Full statistics for data included in Appendix A-2.

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in User's guide (EPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).

The arithmetic mean presented in this table is the mean of the detected values.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) Shapiro-Wilk W Test indicates data are normally distributed.

(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.

(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

(5) The maximum detected concentration was used as the UCL because the value recommended by ProUCL was higher than the Max.

(6) The maximum detected concentration was used as the UCL because the number of detected concentration was less than 2.

G = Gamma distribution.

N = Normal distribution.

T = Log-normal distribution.

Table 3-3
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Exposure Medium: Ambient Air From Total Soil (0-28 ft)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (N/T/G)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Ambient Air from Total Soil Column (0-28 feet)	Trichloroethylene (TCE)	mg/kg	7.8E-01	7.3E-01	4.0E+00	7.3E-01	mg/kg	97.5% KM (Chebyshev) UCL	(4)

Full statistics for data included in Appendix A-2.
ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in User's guide (EPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
The arithmetic mean presented in this table is the mean of the detected values.
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(5) The maximum detected concentration was used as the UCL because the value recommended by ProUCL was higher than the Max.
(6) The maximum detected concentration was used as the UCL because the number of detected concentration was less than 2.
G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.

Table 3.4.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Current/Future
Medium: Indoor Air
Exposure Medium: Indoor Air

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (N/T/G)		Maximum Concentration (Qualifier)	Exposure Point Concentration						
							Initial EPC	Statistic	Rationale	Outdoor Background Value	Blank Detection Value	Final EPC	Units
Manufacturing Building	1,2-Dichloroethylene (cis)	PPBV	7.5E-01	1.0E+00		8.8E-01	8.8E-01	Maximum Concentration	(5)	NA	NA	8.8E-01	PPBV
	Methylene chloride	PPBV	8.6E-01	1.1E+00	(N,T)	1.1E+00	1.1E+00	Maximum Concentration	(5)	NA	NA	1.1E+00	PPBV
	Tetrachloroethylene (PCE)	PPBV	4.8E-01	5.5E-01	(G)	5.8E-01	5.5E-01	Use 95% KM (BCA) UCL	(1)	5.3E-02	NA	4.9E-01	PPBV
	Trichloroethylene (TCE)	PPBV	6.3E+01	5.4E+01	(N,T,G)	6.2E+01	5.4E+01	Use 95% Student's-t UCL	(1,2,3)	2.0E-01	2.5E-02	5.4E+01	PPBV
	Vinyl chloride	PPBV	1.2E-02	1.5E-02		1.5E-02	1.5E-02	Maximum Concentration	(5)	NA	NA	1.5E-02	PPBV

Full statistics for data included in Appendix A-2.
ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in User's guide (EPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
The arithmetic mean presented in this table is the mean of the detected values.
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(5) The maximum detected concentration was used as the UCL because the value recommended by ProUCL was higher than the Max.
(6) The maximum detected concentration was used as the UCL because the number of detected concentration was less than 2.
G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.

TABLE 4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Exposure Medium: Surface Soil (0-3 ft)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Outdoor Industrial Worker	Adult	Surface Soil (0-3 ft)	CS	Chemical Concentration in Soil	RME	mg/kg	RME	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 2002	CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	225	days/year	USEPA, 1991	
				ED	Exposure Duration	25	years	USEPA, 1991	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9125	days	USEPA, 1989	
Dermal	Outdoor Industrial Worker	Adult	Surface Soil (0-3 ft)	CS	Chemical Concentration in Soil	RME	mg/kg	RME	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	USEPA, 2004 (1)	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 2004	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	chem-specific	--	USEPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	225	days/year	USEPA, 1991	
				ED	Exposure Duration	25	years	USEPA, 1991	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	

Notes:

(1) SA includes head, hands, forearms, and lower legs.

Sources:

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USEPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. USEPA/540/R/99/005.

TABLE 4.2.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Receptor: Outdoor Industrial Worker
Exposure Medium: Ambient Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Industrial Worker	Adult	Soil (0-28 ft)	CS	Chemical Concentration in Soil	RME	mg/kg	RME	Chronic Daily Intake (CDI) (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN x EF x ED x 1/BW x 1/AT
				VF	Volatilization Factor	2.17E+03	m^3/kg	USEPA, 1996	CA (mg/m^3) = CS (1/VF)
				IN	Inhalation Rate	20	m^3/day	USEPA, 1991	
				EF	Exposure Frequency	225	days/year	USEPA, 1991	
				ED	Exposure Duration	25	years	USEPA, 1991	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

USEPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

USEPA, 1996: Soil Screening Guidance: User's Guide. USEPA/540/F-95/041.

TABLE 4.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Exposure Medium: Subsurface Soil (0-10 ft)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Construction Worker	Adult	Subsurface Soil (0-10 ft)	CS	Chemical Concentration in Soil	RME	mg/kg	RME	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	330	mg/day	USEPA, 2002	CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	250	days/year	USEPA, 1991	
				ED	Exposure Duration	1	years	USEPA, 2002	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	USEPA, 1989	
Dermal	Construction Worker	Adult	Subsurface Soil (0-10 ft)	CS	Chemical Concentration in Soil	RME	mg/kg	RME	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	USEPA, 2004 (1)	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	USEPA, 2002	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	chem-specific	--	USEPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	250	days/year	USEPA, 1991	
				ED	Exposure Duration	1	years	USEPA, 2002	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	USEPA, 1989	

Notes:

(1) SA includes head, hands, and forearms.

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

USEPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

USEPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. USEPA/540/R/99/005.

TABLE 4.4.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Medium: Soil (the Entire Site)
Receptor: Construction Worker
Exposure Medium: Ambient Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction Worker	Adult	Soil (0-27 ft)	CS	Chemical Concentration in Soil	RME	mg/kg	RME	Chronic Daily Intake (CDI) (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN x EF x ED x 1/BW x 1/AT
				VF	Volatilization Factor	3.04E+03	m^3/kg	USEPA, 1996	CA (mg/m^3) = CS (1/VF)
				IN	Inhalation Rate	20	m^3/day	USEPA,1991	
				EF	Exposure Frequency	250	days/year	USEPA,1991	
				ED	Exposure Duration	1	years	USEPA, 2002	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	USEPA, 1989	

Sources:

MDNR, 2006: Missouri Risk-Based Corrective Action Technical Guidance. April 2006

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

USEPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

USEPA, 1996: Soil Screening Guidance: User's Guide. USEPA/540/F-95/041.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

TABLE 4.5.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Current/Future
Medium: Indoor Air
Exposure Medium: Indoor Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Industrial Worker	Adult	Manufacturing Building	CA	Chemical Concentration in Air	RME	mg/m^3	RME	(CDI) (mg/kg-day) =
				IRA	Air Breathed	1	m^3/hour	USEPA, 1997	CA x IRA x ET x EF x ED x 1/BW x 1/AT
				ET	Exposure Time	9	hours/day	Based on an 8 hour work day, 0.5 hour lunch break, and 0.25 hours on either side of clocking in and out.	
				EF	Exposure Frequency	250	days/year	USEPA, 1991	
				ED	Exposure Duration	25	years	USEPA, 1991	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

USEPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

USEPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa. Washington, D.C. August.

TABLE 4 Supplement 1
Calculation of Volatilization Factor for Outdoor Industrial Worker
Modine Manufacturing Company, Camdenton, Missouri

Chemical	Diffusivity in Air (D_i) (cm^2/s)	Henry's Law Constant (H') (unitless)	Diffusivity in Water (D_w) (cm^2/s)	Soil Organic Carbon Partition Coeff. (K_{oc}) (cm^3/g)	Soil Water Partition Coeff. ($K_d = K_{oc} \times F_{oc}$) ($g/cm^3$)	Solubility in Water (S) (mg/L)	Apparent Diffusivity (D_A) (cm^2/s)	Volatilization Factor (VF) (m^3/kg)
Trichloroethylene (TCE)	7.90E-02	4.22E-01	9.10E-06	9.43E+01	5.66E-01	1.10E+03	2.38E-03	2.17E+03

Volatilization factor (VF) = (m^3/kg)

$$\frac{Q/C * (3.14 * D_A * T)^{1/2} * 10^{-4}\ m^2/cm^2}{2 * r_b * D_A}$$

Apparent Diffusivity (D_A) = (cm^2/s)

$$\frac{[(Q_a^{10/3} * D_i * H' + Q_w^{10/3} * D_w)/n^2]}{(r_b * K_d + Q_w + Q_a * H')}$$

Soil Saturation Concentration (C_{sat}) = (mg/kg)

$$S/r_b * (K_d * r_b + Q_w + H' * Q_a)$$

Parameters	Values
Q/C - Inverse of the mean concentration at the center of a 1-acre-square source (g/m^2-s per kg/m^3)	58.18
T - Exposure interval(s)	9.5E+08
r_b - Soil bulk density (g/cm^3)	1.5
Q_a - Air-filled soil porosity (L_{air}/L_{water}) = n - Q_w	0.28
n - Total soil porosity (Lpore/Lsoil) = 1 - (r_b/r_s)	0.43
Q_w - Water-filled soil porosity (Lwater/Lsoil)	0.15
r_s - Soil particle density (g/cm^3)	2.65
f_{oc} - fraction organic carbon in soil (g/g)	0.006

Notes
Q/C Based on EPA document review comments

TABLE 4 Supplement 2
Calculation of Volatilization Factor for the Construction Worker Scenario
Modine Manufacturing Company, Camdenton, Missouri

Chemical	Diffusivity in Air (D_i) (cm^2/s)	Henry's Law Constant (H') (unitless)	Diffusivity in Water (D_w) (cm^2/s)	Soil Organic Carbon Partition Coeff. (K_{oc}) (cm^3/g)	Soil Water Partition Coeff. ($K_d = K_{oc} \times F_{oc}$) ($g/cm^3$)	Solubility in Water (S) (mg/L)	Apparent Diffusivity (D_A) (cm^2/s)	Volatilization Factor (VF) (m^3/kg)
Trichloroethylene (TCE)	7.90E-02	4.22E-01	9.10E-06	9.43E+01	5.66E-01	1.10E+03	2.38E-03	3.04E+03

Volatilization factor (VF) = (m^3/kg)

$$\frac{Q/C * (3.14 * D_A * T)^{1/2} * 10^{-4}\ m^2/cm^2}{2 * r_b * D_A}$$

Apparent Diffusivity (D_A) = (cm^2/s)

$$\frac{[(Q_a^{10/3} * D_i * H' + Q_w^{10/3} * D_w)/n^2]}{(r_b * K_d + Q_w + Q_a * H')}$$

Soil Saturation Concentration (C_{sat}) = (mg/kg)

$$S/r_b * (K_d * r_b + Q_w + H' * Q_a)$$

Parameters	Values
Q/C - Inverse of the mean concentration at the center of a 1-acre-square source (g/m^2-s per kg/m^3)	14.31
T - Exposure interval(s)	9.5E+08
r_b - Soil bulk density (g/cm^3)	1.5
Q_a - Air-filled soil porosity (L_{air}/L_{water}) = n - Q_w	0.28
n - Total soil porosity (Lpore/Lsoil) = 1 - (ρ_b/r_s)	0.43
Q_w - Water-filled soil porosity (Lwater/Lsoil)	0.15
r_s - Soil particle density (g/cm^3)	2.65
f_{oc} - fraction organic carbon in soil (g/g)	0.006

Note:
Q/C value is the EPA default for Construction Workers (EPA, 2002).

TABLE 5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

Modine Manufacturing Company, Camdenton, Missouri

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Trichloroethylene (TCE)	Chronic	3.0E-04	mg/kg-day	> 50%	3.0E-04	mg/kg-day	liver, kidney, fetus	NA	EPA, 2001	08/2001
Trichloroethylene (TCE)	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note:

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Section 4.2 and Exhibit 4-1. EPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%. Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.

(2) Risk assessment text will describe the derivation of the "Absorbed RfD for Dermal"

Definitions: NA = Not Available

IRIS = Integrated Risk Information System

NCEA = National Center for Environmental Assessment

EPA. 2001. Trichloroethylene Health Risk Assessment: Synthesis and Characterization. External Review Draft. Office of Research and Development.

TABLE 5.2

NON-CANCER TOXICITY DATA -- INHALATION

Modine Manufacturing Company, Camdenton, Missouri

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD (1)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
1,2-Dichloroethylene (cis)	Chronic	6.0E-02	mg/m3	1.7E-02	mg/kg-day	Lung	NA	PPRTV (2)	11/12/2008
1,2-Dichloroethylene (cis)	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	Chronic	1.1E+00	mg/m3	3.0E-01	mg/kg-day	liver	NA	ATSDR	02/2001
Methylene chloride	Subchronic	3.0E+00	mg/m3	8.6E-01	mg/kg-day	liver	NA	HEAST	12/8/2008
Tetrachloroethylene (PCE)	Chronic	NA	NA	NA	NA	NA	NA	NA	6/2006
Tetrachloroethylene (PCE)	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene (TCE)	Chronic	6.0E-01	mg/m3	1.7E-01	mg/kg-day	nervous system, eyes	NA	CalEPA, 2008	3/10/2008
Trichloroethylene (TCE)	Chronic	4.0E-02	mg/m3	1.1E-02	mg/kg-day	liver, kidney, fetus	NA	EPA, 2001	08/2001
Trichloroethylene (TCE)	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	Chronic	1.0E-01	mg/m3	2.9E-02	mg/kg-day	liver	30/1	IRIS	03/30/2006
Vinyl chloride	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA

Note:

(1) See Risk Assessment text for the derivation of the "Extrapolated RfD".

(2) The PPRTV inhalation RfC for trans-1,2-Dichloroethene used for cis-1,2-Dichloroethene

Definitions: NA = Not Available

IRIS = Integrated Risk Information System

EPA. 2001. Trichloroethylene Health Risk Assessment: Synthesis and Characterization. External Review Draft. Office of Research and Development.

CalEPA - OEHHA Toxicity Criteria Database.

ATSDR - Agency for Toxic Substances and Disease Registry

HEAST - EPA Superfund Health Effects Assessment Summary Tables

PPRTV - EPA Superfund Health Risk Technical Support Center (STSC) Provisional Peer Re

TABLE 6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

Modine Manufacturing Company, Camdenton, Missouri

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Trichloroethylene (TCE)	1.3E-02	$(mg/kg\text{-}day)^{-1}$	> 50%	1.3E-02	$(mg/kg\text{-}day)^{-1}$	2A	CalEPA, 2008	3/10/2008
Trichloroethylene (TCE)	4.0E-01	$(mg/kg\text{-}day)^{-1}$	> 50%	4.0E-01	$(mg/kg\text{-}day)^{-1}$	Note 1	EPA, 2001	08/2001

Note:

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Section 4.2 and Exhibit 4-1. EPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%. Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.

Definitions:

NA = Not Available

IRIS = Integrated Risk Information System

EPA. 2001. Trichloroethylene Health Risk Assessment: Synthesis and Characterization. External Review Draft. Office of Research and Development.

Continuous lifetime exposure during adulthood value was used for vinyl chloride

CalEPA - OEHHA Toxicity Criteria Database.

Weight of Evidence definitions:

Note 1 - According to the 2001 draft TCE Assessment, TCE is highly likely to produce cancer in humans.

* The Cal EPA classifies weight of evidence using both EPA and International Agency for Research on Cancer (IARC) definitions

An IARC classification of 2A is defined as "The agent is probably carcinogenic to humans."

TABLE 6.2

CANCER TOXICITY DATA -- INHALATION

Modine Manufacturing Company, Camdenton, Missouri

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
1,2-Dichloroethylene (cis)	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	1.0E-06	$(ug/m^3)^{-1}$	3.5E-03	$(mg/kg\text{-}day)^{-1}$	2B*	CalEPA, 2008	12/8/2008
Tetrachloroethylene (PCE)	5.9E-06	$(ug/m^3)^{-1}$	2.1E-02	$(mg/kg\text{-}day)^{-1}$	2B*	CalEPA, 2008	12/8/2008
Trichloroethylene (TCE)	2.0E-06	$(ug/m^3)^{-1}$	7.0E-03	$(mg/kg\text{-}day)^{-1}$	2A*	CalEPA, 2008	3/10/2008
Trichloroethylene (TCE)	NA	NA	4.0E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA, 2001	08/2001
Vinyl chloride	4.4E-06	$(ug/m^3)^{-1}$	1.5E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	03/30/2006

Definitions:

NA = Not Available

IRIS = Integrated Risk Information System

EPA. 2001. Trichloroethylene Health Risk Assessment: Synthesis and Characterization. External Review Draft. Office of Research and Development.

According to the 2001 draft TCE Assessment, TCE is highly likely to produce cancer in hur

Continuous lifetime exposure during adulthood value was used for vinyl chloride

CalEPA - OEHHA Toxicity Criteria Database.

EPA Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.

Group B1 chemicals (probable human carcinogens) are agents for which there is limited evidence of possible carcinogenicity in humans.

Group B2 chemicals (probable human carcinogens) are agents for which there is sufficient evidence of carcinogenicity in animals but inadequate or a lack of evidence in humans.

Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals and inadequate or a lack of human data.

Group D chemicals (not classifiable as to human carcinogenicity) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.

Group E chemicals (evidence of noncarcinogenicity in humans) are agents for which there is no evidence of carcinogenicity from human or animal studies, or both.

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Receptor Population: Outdoor Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil (the Entire Site)	Surface Soil (0-3 ft)	Surface Soil (0-3 ft)	Ingestion	Trichloroethylene (TCE)	3.7E-01	mg/kg	1.2E-07	mg/kg/day	1.3E-02	1/(mg/kg/day)	1.5E-09	3.3E-07	mg/kg/day	NA	NA	NA
			Exp. Route Total								1.5E-09					0.0E+00
Soil (the Entire Site)	Surface Soil (0-3 ft)	Surface Soil (0-3 ft)	Dermal	Trichloroethylene (TCE)	3.7E-01	mg/kg	7.8E-09	mg/kg/day	1.3E-02	1/(mg/kg/day)	1.0E-10	2.2E-08	mg/kg/day	NA	NA	NA
			Exp. Route Total								1.0E-10					0.0E+00
		Exposure Point Total									1.6E-09					0.0E+00
	Exposure Medium Total										1.6E-09					0.0E+00
Soil (the Entire Site)	Ambient Air From Soil (0-28 ft)	Ambient Air	Inhalation	Trichloroethylene (TCE)	3.4E-04	mg/m3	2.1E-05	mg/kg/day	7.0E-03	1/(mg/kg/day)	1.5E-07	6.0E-05	mg/kg/day	1.7E-01	mg/kg/day	3.5E-04
			Exp. Route Total								1.5E-07					3.5E-04
		Exposure Point Total									1.5E-07					3.5E-04
	Exposure Medium Total										1.5E-07					3.5E-04
Soil Total											1.5E-07					3.5E-04
Receptor Total											1.5E-07					3.5E-04

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil (the Entire Site)	Subsurface Soil (0-10 ft)	Subsurface Soil (0-10 ft)	Ingestion	Trichloroethylene (TCE)	4.2E-01	mg/kg	1.9E-08	mg/kg/day	1.3E-02	1/(mg/kg/day)	2.5E-10	1.3E-06	mg/kg/day	NA	NA	NA
			Exp. Route Total								2.5E-10					0.0E+00
Soil (the Entire Site)	Subsurface Soil (0-10 ft)	Subsurface Soil (0-10 ft)	Dermal	Trichloroethylene (TCE)	4.2E-01	mg/kg	5.8E-10	mg/kg/day	1.3E-02	1/(mg/kg/day)	7.5E-12	4.0E-08	mg/kg/day	NA	NA	NA
			Exp. Route Total								7.5E-12					0.0E+00
		Exposure Point Total									2.6E-10					0.0E+00
	Exposure Medium Total										2.6E-10					0.0E+00
Soil (the Entire Site)	Ambient Air From Soil (0-28 ft)	Ambient Air	Inhalation	Trichloroethylene (TCE)	1.7E-05	mg/m3	4.6E-08	mg/kg/day	7.0E-03	1/(mg/kg/day)	3.2E-10	3.2E-06	mg/kg/day	1.7E-01	mg/kg/day	1.9E-05
			Exp. Route Total								3.2E-10					1.9E-05
		Exposure Point Total									3.2E-10					1.9E-05
	Exposure Medium Total										3.2E-10					1.9E-05
Soil Total											5.8E-10					1.9E-05
Receptor Total											5.8E-10					1.9E-05

NA = Not applicable.

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Current/Future
Receptor Population: Indoor Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Indoor Air	Indoor Air	Manufacturing Building	Inhalation	1,2-Dichloroethylene (cis)	3.5E-03	mg/m3	1.1E-04	mg/kg/day	NA	NA	NA	3.1E-04	mg/kg/day	1.7E-02	mg/kg/day	1.8E-02
				Methylene chloride	3.9E-03	mg/m3	1.2E-04	mg/kg/day	3.5E-03	1/(mg/kg/day)	4.3E-07	3.5E-04	mg/kg/day	3.0E-01	mg/kg/day	1.2E-03
				Tetrachloroethylene (PCE)	3.3E-03	mg/m3	1.1E-04	mg/kg/day	2.1E-02	1/(mg/kg/day)	2.2E-06	2.9E-04	mg/kg/day	NA	NA	NA
				Trichloroethylene (TCE)	2.9E-01	mg/m3	9.1E-03	mg/kg/day	7.0E-03	1/(mg/kg/day)	6.4E-05	2.5E-02	mg/kg/day	1.7E-01	mg/kg/day	1.5E-01
				Vinyl chloride	3.8E-05	mg/m3	1.2E-06	mg/kg/day	1.5E-02	1/(mg/kg/day)	1.9E-08	3.4E-06	mg/kg/day	2.9E-02	mg/kg/day	1.2E-04
			Exp. Route Total								6.6E-05					1.7E-01
		Exposure Point Total									6.6E-05					1.7E-01
	Exposure Medium Total										6.6E-05					1.7E-01
Soil Total											6.6E-05					1.7E-01
Receptor Total											6.6E-05					1.7E-01

TABLE 9.1.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Receptor Population: Outdoor Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (the Entire Site)	Surface Soil (0-3 ft)	Surface Soil (0-3 ft)	Trichloroethylene (TCE)	2E-09	NA	1E-10	2E-09	liver, kidney, fetus	NA	NA	NA	NA
		Exposure Point Total		2E-09	NA	1E-10	2E-09		0E+00	NA	0E+00	0E+00
	Exposure Medium Total			2E-09	NA	1E-10	2E-09		0E+00	NA	0E+00	0E+00
	Ambient Air From Soil (0-28 ft)	Ambient Air	Trichloroethylene (TCE)	NA	1E-07	NA	1E-07	liver, kidney, fetus	NA	4E-04	NA	4E-04
		Exposure Point Total		NA	1E-07	NA	1E-07		NA	4E-04	NA	4E-04
	Exposure Medium Total			NA	1E-07	NA	1E-07		NA	4E-04	NA	4E-04
Medium Total				2E-09	1E-07	1E-10	2E-07		0E+00	4E-04	0E+00	4E-04
Receptor (Future Outdoor Industrial Worker) Total				2E-09	1E-07	1E-10	2E-07		0E+00	4E-04	0E+00	4E-04

Total Kidney HI Across Media =	4E-04
Total Liver HI Across Media =	4E-04
Total Fetus HI Across Media =	4E-04

TABLE 9.2.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (the Entire Site)	Subsurface Soil (0-10 ft)	Subsurface Soil (0-10 ft)	Trichloroethylene (TCE)	3E-10	NA	8E-12	3E-10	liver, kidney, fetus	NA	NA	NA	NA
		Exposure Point Total		3E-10	NA	8E-12	3E-10		0E+00	NA	0E+00	0E+00
	Exposure Medium Total			3E-10	NA	8E-12	3E-10		0E+00	NA	0E+00	0E+00
	Ambient Air From Soil (0-28 ft)	Ambient Air	Trichloroethylene (TCE)	NA	3E-10	NA	3E-10	liver, kidney, fetus	NA	2E-05	NA	2E-05
		Exposure Point Total		NA	3E-10	NA	3E-10		NA	2E-05	NA	2E-05
	Exposure Medium Total			NA	3E-10	NA	3E-10		NA	2E-05	NA	2E-05
Medium Total				3E-10	3E-10	8E-12	6E-10		0E+00	2E-05	0E+00	2E-05
Receptor (Future Construction Worker) Total				3E-10	3E-10	8E-12	6E-10		0E+00	2E-05	0E+00	2E-05

Total Kidney HI Across Media =	2E-05
Total Liver HI Across Media =	2E-05
Total Fetus HI Across Media =	2E-05

TABLE 9.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Modine Manufacturing Company, Camdenton, Missouri

Scenario Timeframe: Current/Future
Receptor Population: Indoor Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Indoor Air	Indoor Air	Manufacturing Building	cis-1,2-Dichloroethene	NA	NA	NA	NA	Lung	NA	4E-02	NA	2E-02
			Methylene chloride	NA	4.3E-07	NA	4E-07	Liver	NA	2E-03	NA	1E-03
			Tetrachloroethene	NA	2.2E-06	NA	2E-06	NA	NA	NA	NA	NA
			Trichloroethene	NA	6.4E-05	NA	6E-05	Liver, Kidney, Fetus	NA	3E-01	NA	1E-01
			Vinyl chloride	NA	1.9E-08	NA	2E-08	Liver	NA	2E-04	NA	1E-04
		Exposure Point Total		NA	7E-05	NA	7E-05		NA	3E-01	NA	2E-01
	Exposure Medium Total			NA	7E-05	NA	7E-05		NA	3E-01	NA	2E-01
Medium Total				NA	7E-05	NA	7E-05		NA	3E-01	NA	2E-01
Receptor (Future Industrial Worker) Total				NA	7E-05	NA	7E-05		NA	3E-01	NA	2E-01

Total Kidney HI Across Media =	1E-01
Total Liver HI Across Media =	2E-01
Total Lung HI Across Media =	2E-02
Total Fetus HI Across Media =	1E-01

TABLE 9.3.RME Supplement
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR TRICHLOROETHYLENE
REASONABLE MAXIMUM EXPOSURE
Modine Manufacturing Company, Camdenton, Missouri

Chemical of Potential Concern	CSF (Ingestion/Dermal) 1/(mg/kg/day)	CSF (Inhalation) 1/(mg/kg/day)	Reference	Carcinogenic Risk					
				Future Outdoor Industrial Workers				Current Indoor Industrial Workers	
				Ingestion	Dermal	Inhalation (Ambient Air)	Exposure Routes Total	Inhalation (Indoor Air)	Exposure Routes Total
Trichloroethylene (TCE)	1.3E-02	7.0E-03	(Cal/EPA)	2E-09	1E-10	1E-07	2E-07	6E-05	6E-05
Trichloroethylene (TCE)	4.0E-01	4.0E-01	(EPA, 2001)	5E-08	3E-09	9E-06	9E-06	4E-03	4E-03

Chemical of Potential Concern	RfD (Ingestion/Dermal) (mg/kg/day)	RfD (Inhalation) (mg/kg/day)	Reference	Non-Cancer Hazard Calculations					
				Future Outdoor Industrial Workers				Current Indoor Industrial Workers	
				Ingestion	Dermal	Inhalation (Ambient Air)	Exposure Routes Total	Inhalation (Indoor Air)	Exposure Routes Total
Trichloroethylene (TCE)	NA	1.7E-01	(Cal/EPA)	NA	NA	4E-04	4E-04	1E-01	1E-01
Trichloroethylene (TCE)	3.0E-04	1.1E-02	(EPA, 2001)	1E-03	7E-05	5E-03	6E-03	2E+00	2E+00

Reference:

EPA. 2001. Trichloroethylene Health Risk Assessment: Synthesis and Characterization. External Review Draft. Office of Research and Development.

Cal/EPA = California Environmental Protection Agency

Appendix A-2
ProUCL Output

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	ON
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Trichloroethylene (TCE) [SO Const]

General Statistics

Number of Valid Samples	126	Number of Detected Data	38
Number of Unique Samples	36	Number of Non-Detect Data	88
		Percent Non-Detects	69.84%

Raw Statistics

Minimum Detected	0.0021
Maximum Detected	4
Mean of Detected	0.5468711
SD of Detected	1.0792459
Minimum Non-Detect	0.001
Maximum Non-Detect	0.068

Log-transformed Statistics

Minimum Detected	-6.165818
Maximum Detected	1.3862944
Mean of Detected	-2.338218
SD of Detected	1.9745428
Minimum Non-Detect	-6.907755
Maximum Non-Detect	-2.688248

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	106
Number treated as Detected	20
Single DL Non-Detect Percentage	84.13%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.5470806
5% Lilliefors Critical Value	0.938

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.9623863
5% Lilliefors Critical Value	0.938

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.1708056
SD	0.637468
95% DL/2 (t) UCL	0.2649145

Maximum Likelihood Estimate(MLE) Method N/A

MLE yields a negative mean

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-4.35988
SD	1.9237446
95% H-Stat (DL/2) UCL	0.1159794

Log ROS Method

Mean in Log Scale	-6.362667
SD in Log Scale	3.1947939
Mean in Original Scale	0.165635
SD in Original Scale	0.6387782
95% Percentile Bootstrap UCL	0.2682922
95% BCA Bootstrap UCL	0.2833273

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.3695246
Theta Star	1.4799315
nu star	28.083868
A-D Test Statistic	2.1174992
5% A-D Critical Value	0.8389424
K-S Test Statistic	0.8389424
5% K-S Critical Value	0.153749

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.0021
Maximum	4
Mean	0.5501776
Median	0.5305068
SD	0.5879448
k star	1.0689807
Theta star	0.514675
Nu star	269.38314
AppChi2	232.37425
95% Gamma Approximate UCL	0.6378012
95% Adjusted Gamma UCL	0.6388848

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.1669423
SD	0.6359053
SE of Mean	0.0574122
95% KM (t) UCL	0.262082
95% KM (z) UCL	0.2613769
95% KM (jackknife) UCL	0.2606889
95% KM (bootstrap t) UCL	0.3113009
95% KM (BCA) UCL	0.275936
95% KM (Percentile Bootstrap) UCL	0.2639127
95% KM (Chebyshev) UCL	0.4171962
97.5% KM (Chebyshev) UCL	0.5254812
99% KM (Chebyshev) UCL	0.7381862

Potential UCLs to Use

95% KM (Chebyshev) UCL 0.4171962

Trichloroethylene (TCE) [SO Indust]

General Statistics

Number of Valid Samples	49	Number of Detected Data	11
Number of Unique Samples	10	Number of Non-Detect Data	38
		Percent Non-Detects	77.55%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.008	Minimum Detected	-4.828314
Maximum Detected	3	Maximum Detected	1.0986123
Mean of Detected	0.3754545	Mean of Detected	-2.904156
SD of Detected	0.8989527	SD of Detected	1.8898657
Minimum Non-Detect	0.001	Minimum Non-Detect	-6.907755
Maximum Non-Detect	0.0074	Maximum Non-Detect	-4.906275

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	38
Number treated as Detected	11
Single DL Non-Detect Percentage	77.55%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.4772144	Shapiro Wilk Test Statistic	0.8839229
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0863092	Mean	-5.373536
SD	0.4393904	SD	1.6901385
95% DL/2 (t) UCL	0.1915886	95% H-Stat (DL/2) UCL	0.0343883
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-8.740079
		SD in Log Scale	3.6140318
		Mean in Original Scale	0.0843575
		SD in Original Scale	0.4397702
		95% Percentile Bootstrap UCL	0.2049226
		95% BCA Bootstrap UCL	0.3102505

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.3147774	Data appear Lognormal at 5% Significance Level
Theta Star	1.1927622	
nu star	6.925102	
A-D Test Statistic	1.2778442	
5% A-D Critical Value	0.8104554	
K-S Test Statistic	0.8104554	
5% K-S Critical Value	0.274185	
Data not Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution		Nonparametric Statistics	
Gamma ROS Statistics using Extrapolated Data		Kaplan-Meier (KM) Method	
Minimum	0	Mean	0.0904898
Maximum	3	SD	0.4340833
Mean	0.4323221	SE of Mean	0.0650386
Median	0.1673236	95% KM (t) UCL	0.1995741
SD	0.6726406	95% KM (z) UCL	0.1974688
k star	0.1411835	95% KM (jackknife) UCL	0.1955755
Theta star	3.0621295	95% KM (bootstrap t) UCL	2.1576236
Nu star	13.835982	95% KM (BCA) UCL	0.2149592
AppChi2	6.4592	95% KM (Percentile Bootstrap) UCL	0.2082449
95% Gamma Approximate UCL	0.9260592	95% KM (Chebyshev) UCL	0.3739866
95% Adjusted Gamma UCL	0.9485592	97.5% KM (Chebyshev) UCL	0.4966559
		99% KM (Chebyshev) UCL	0.737616
		Potential UCLs to Use	
		95% KM (Chebyshev) UCL	0.3739866

Note: DL/2 is not a recommended method.

Trichloroethylene (TCE) (mg/kg) [Soil 0-27ft for Ambient Air Calculation]

General Statistics

Number of Valid Data	137	Number of Detected Data	49
Number of Distinct Detected Data	46	Number of Non-Detect Data	88
		Percent Non-Detects	64.23%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0021	Minimum Detected	-6.166
Maximum Detected	4	Maximum Detected	1.386
Mean of Detected	0.778	Mean of Detected	-1.992
SD of Detected	1.275	SD of Detected	2.148
Minimum Non-Detect	0.001	Minimum Non-Detect	-6.908
Maximum Non-Detect	0.068	Maximum Non-Detect	-2.688

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	108
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	29
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	78.83%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.627	Lilliefors Test Statistic	0.945
5% Lilliefors Critical Value	0.947	5% Lilliefors Critical Value	0.947
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.284	Mean	-4.074
SD	0.843	SD	2.183
95% DL/2 (t) UCL	0.403	95% H-Stat (DL/2) UCL	0.252

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-5.692
		SD in Log Scale	3.328
		Mean in Original Scale	0.279
		SD in Original Scale	0.845
		95% Percentile Bootstrap UCL	0.403
		95% BCA Bootstrap UCL	0.426

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.371	Data do not follow a Discernable Distribution (0.05)
Theta Star	2.097	
nu star	36.37	
A-D Test Statistic	1.871	**Nonparametric Statistics**
5% A-D Critical Value	0.843	Kaplan-Meier (KM) Method
K-S Test Statistic	0.843	Mean 0.28
5% K-S Critical Value	0.136	SD 0.841
Data not Gamma Distributed at 5% Significance Level		SE of Mean 0.0726
		95% KM (t) UCL 0.401
Assuming Gamma Distribution		95% KM (z) UCL 0.4
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 0.399
Minimum	0.0021	95% KM (bootstrap t) UCL 0.427
Maximum	4	95% KM (BCA) UCL 0.417
Mean	0.78	95% KM (Percentile Bootstrap) UCL 0.405
Median	0.761	95% KM (Chebyshev) UCL 0.597
SD	0.758	97.5% KM (Chebyshev) UCL 0.734
k star	0.918	99% KM (Chebyshev) UCL 1.003
Theta star	0.849	
Nu star	251.6	**Potential UCLs to Use**
AppChi2	215.8	97.5% KM (Chebyshev) UCL 0.734
95% Gamma Approximate UCL	0.909	
95% Adjusted Gamma UCL	0.91	

Note: DL/2 is not a recommended method.

cis-1,2-Dichloroethene(PPBV) [Indoor Air]

General Statistics

Number of Valid Data	6	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	4
		Percent Non-Detects	66.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.62	Minimum Detected	-0.478
Maximum Detected	0.88	Maximum Detected	-0.128
Mean of Detected	0.75	Mean of Detected	-0.303
SD of Detected	0.184	SD of Detected	0.248
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	4.5	Maximum Non-Detect	1.504

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	6
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	1	Shapiro Wilk Test Statistic	1
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.07	Mean	-0.0551
SD	0.628	SD	0.527
95% DL/2 (t) UCL	1.586	95% H-Stat (DL/2) UCL	6.714
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)
Theta Star	N/A	
nu star	N/A	
A-D Test Statistic	0.359	
5% A-D Critical Value	N/A	
K-S Test Statistic	N/A	
5% K-S Critical Value	N/A	
Data not Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution		Nonparametric Statistics	
Gamma ROS Statistics using Extrapolated Data		Kaplan-Meier (KM) Method	
Minimum	N/A	Mean	0.75
Maximum	N/A	SD	0.13
Mean	N/A	SE of Mean	0.13
Median	N/A	95% KM (t) UCL	1.012
SD	N/A	95% KM (z) UCL	0.964
k star	N/A	95% KM (jackknife) UCL	1.088
eta star	N/A	95% KM (bootstrap t) UCL	1.8E+308
nu star	N/A	95% KM (BCA) UCL	0.88
AppChi2	N/A	95% KM (Percentile Bootstrap) UCL	0.88
95% Gamma Approximate UCL	N/A	95% KM (Chebyshev) UCL	1.317
95% Adjusted Gamma UCL	N/A	97.5% KM (Chebyshev) UCL	1.562
		99% KM (Chebyshev) UCL	2.043
		Potential UCLs to Use	
		95% KM (t) UCL	1.012
		95% KM (% Bootstrap) UCL	0.88

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Methylene chloride(PPBV) [Indoor Air]

General Statistics

Number of Valid Data	6	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	3
		Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.64	Minimum Detected	-0.446
Maximum Detected	1.13	Maximum Detected	0.122
Mean of Detected	0.86	Mean of Detected	-0.178
SD of Detected	0.249	SD of Detected	0.286
Minimum Non-Detect	2.01	Minimum Non-Detect	0.698
Maximum Non-Detect	4.5	Maximum Non-Detect	1.504

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	6
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.97	Shapiro Wilk Test Statistic	0.99
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.167	Mean	0.0723
SD	0.567	SD	0.426
95% DL/2 (t) UCL	1.633	95% H-Stat (DL/2) UCL	4.36

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.178
		SD in Log Scale	0.181
		Mean in Original Scale	0.848
		SD in Original Scale	0.158
		95% Percentile Bootstrap UCL	0.946
		95% BCA Bootstrap UCL	0.934

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level
Theta Star	N/A	
nu star	N/A	

A-D Test Statistic	0.267	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.86
5% K-S Critical Value	N/A	SD	0.203
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.144
		95% KM (t) UCL	1.149
Assuming Gamma Distribution		95% KM (z) UCL	1.096
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.184
Minimum	N/A	95% KM (bootstrap t) UCL	1.46
Maximum	N/A	95% KM (BCA) UCL	1.13
Mean	N/A	95% KM (Percentile Bootstrap) UCL	1.13
Median	N/A	95% KM (Chebyshev) UCL	1.486
SD	N/A	97.5% KM (Chebyshev) UCL	1.757
k star	N/A	99% KM (Chebyshev) UCL	2.289
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	95% KM (t) UCL	1.149
95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL	1.13
95% Adjusted Gamma UCL	N/A		

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Tetrachloroethylene (PCE) - (PPTV) [Indoor Air]

General Statistics

Number of Valid Observations	6	Number of Distinct Observations	6

Raw Statistics		**Log-transformed Statistics**	
Minimum	200	Minimum of Log Data	5.298
Maximum	602	Maximum of Log Data	6.4
Mean	478	Mean of log Data	6.111
Median	522.5	SD of log Data	0.412
SD	146.9		
Coefficient of Variation	0.307		
Skewness	-1.745		

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.819	Shapiro Wilk Test Statistic	0.725
Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	598.9	95% H-UCL	770.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	838.5
95% Adjusted-CLT UCL	531	97.5% Chebyshev (MVUE) UCL	992
95% Modified-t UCL	591.7	99% Chebyshev (MVUE) UCL	1293

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.493	Data appear Normal at 5% Significance Level	
Theta Star	106.4		
nu star	53.92		
Approximate Chi Square Value (.05)	38.05	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0122	95% CLT UCL	576.6
Adjusted Chi Square Value	33.3	95% Jackknife UCL	598.9
		95% Standard Bootstrap UCL	568.6
Anderson-Darling Test Statistic	0.773	95% Bootstrap-t UCL	562
Anderson-Darling 5% Critical Value	0.698	95% Hall's Bootstrap UCL	538.5
Kolmogorov-Smirnov Test Statistic	0.303	95% Percentile Bootstrap UCL	557.3
Kolmogorov-Smirnov 5% Critical Value	0.333	95% BCA Bootstrap UCL	545
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	739.4
		97.5% Chebyshev(Mean, Sd) UCL	852.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1075
95% Approximate Gamma UCL	677.4		
95% Adjusted Gamma UCL	774		

Potential UCL to Use		Use 95% Student's-t UCL	598.9

Trichloroethylene (TCE) - (PPTV) [Indoor Air]

General Statistics

Number of Valid Observations	6	Number of Distinct Observations	6

Raw Statistics		**Log-transformed Statistics**	
Minimum	21900	Minimum of Log Data	9.994
Maximum	102000	Maximum of Log Data	11.53
Mean	62867	Mean of log Data	10.95
Median	62100	SD of log Data	0.523
SD	26583		
Coefficient of Variation	0.423		
Skewness	-0.121		

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Test Statistic	0.892
Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	84735	95% H-UCL	122922
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	123195
95% Adjusted-CLT UCL	80144	97.5% Chebyshev (MVUE) UCL	148877
95% Modified-t UCL	84646	99% Chebyshev (MVUE) UCL	199325

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.772	Data appear Normal at 5% Significance Level	
Theta Star	22679		
nu star	33.26		
Approximate Chi Square Value (.05)	21.08	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0122	95% CLT UCL	80718
Adjusted Chi Square Value	17.66	95% Jackknife UCL	84735
		95% Standard Bootstrap UCL	79083
Anderson-Darling Test Statistic	0.317	95% Bootstrap-t UCL	83884
Anderson-Darling 5% Critical Value	0.698	95% Hall's Bootstrap UCL	82934
Kolmogorov-Smirnov Test Statistic	0.24	95% Percentile Bootstrap UCL	79383
Kolmogorov-Smirnov 5% Critical Value	0.333	95% BCA Bootstrap UCL	77717
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	110172
		97.5% Chebyshev(Mean, Sd) UCL	130641
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	170848
95% Approximate Gamma UCL	99217		
95% Adjusted Gamma UCL	118395		

Potential UCL to Use		
	Use 95% Student's-t UCL	84735

Vinyl chloride(PPTV) [Indoor Air]

General Statistics

Number of Valid Data	6	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	4
		Percent Non-Detects	66.67%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	9	Minimum Detected	2.197
Maximum Detected	15	Maximum Detected	2.708
Mean of Detected	12	Mean of Detected	2.453
SD of Detected	4.243	SD of Detected	0.361
Minimum Non-Detect	17	Minimum Non-Detect	2.833
Maximum Non-Detect	32	Maximum Non-Detect	3.466
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	6
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	1	Shapiro Wilk Test Statistic	1
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	12.17	Mean	2.459
SD	3.67	SD	0.309
95% DL/2 (t) UCL	15.19	95% H-Stat (DL/2) UCL	40.27
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	0.359	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	12
5% K-S Critical Value	N/A	SD	3
Data not Gamma Distributed at 5% Significance Level		SE of Mean	3
		95% KM (t) UCL	18.05
Assuming Gamma Distribution		95% KM (z) UCL	16.93
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	19.8
Minimum	N/A	95% KM (bootstrap t) UCL	1.8E+308
Maximum	N/A	95% KM (BCA) UCL	N/A
Mean	N/A	95% KM (Percentile Bootstrap) UCL	N/A
Median	N/A	95% KM (Chebyshev) UCL	25.08
SD	N/A	97.5% KM (Chebyshev) UCL	30.73
k star	N/A	99% KM (Chebyshev) UCL	41.85
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	18.05
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.